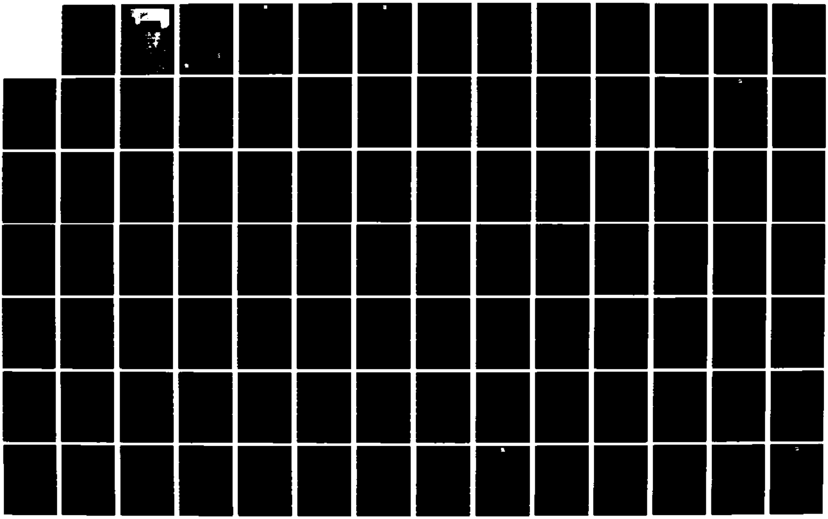
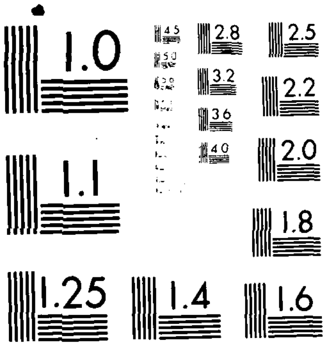
AD-A162 778   RADIATION-HARD BREADBOARD STAR TRACKER ATTACHMENT 1(U)   1/2
BALL AEROSPACE SYSTEMS DIV BOULDER CO
M W HUBBARD ET AL SEP 85 BASD/F85-03-1
UNCLASSIFIED   N00014-82-6(C)-2488   F/G 9/2   NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

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Attachment I

Final Report for

DIATION-HARD BREADBOARD STAR TRACKER

F85-03 September 1985

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Attachment I

Final Report for

RADIATION-HARD BREADBOARD STAR TRACKER

F85-03 September 1985

Prepared for

Naval Research Laboratory
Washington, D.C.

Contract N00014-82-6(C)-2488

Ball Aerospace Systems Division

BOULDER, COLORADO 80306

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Section I–1

Section I-1
STAR TRACKER CONTROL PROGRAM LISTING

9816 Program NRL

```
10     !                    PROGRAM "NEWNRL"
20     !
30     !                    Written by Kris Parrish
40     !                    April 11, 1985
50     !
60     !                    This is a new program to be used with the
70     !                    NRL tracker and Phil McCollum's interface box.
80     !
90     !
100    DIM Clear$[2],Off_flag$[8],On_flag$[8],Disp_flag$[8],Auto_flag$[13]
110    DIM Auto_disp_flag$[13],Star_data(100,12),Read_string$[20]
120    DIM Send_msg$[35],File_string$[7],Disk_string$[14],Ctble(15)
130    DIM Err_msg$[30]
140    !
150    !     ******************************************
160    !     *          Initialize variables and flags   *
170    !     ******************************************
180    !
190    !
200    Test_flag=0                         ! For use w/ the interface box
210                                        ! 0 is with, 1 is without
220    Self_test_flag=0                    ! Self test ON/OFF to OFF
230    Star1_flag=1                        ! Star #1 enabled
240    Star2_flag=1                        ! Star #2 enabled
250    Star3_flag=1                        ! Star #3 enabled
260                                        !             0 is disabled...
270    Curr_star=3                         ! Current star
280    X_posn=128                          ! Current X position
290    Y_posn=128                          ! Current Y position
300    Adapt_rate_flag=0                   ! Adaptive Rate ON/OFF to OFF, 1 is ON
310    Acqu_flag=1                         ! Acquisition AUTO/MANUAL to AUTO
320                                        ! 0 is MANUAL, 1 is AUTO
330    Acqu_type=1                         ! Acquisition type is FULL FOV,
340                                        ! 0 is OFF, 1 is FULL FOV, 2 is FULL EDGE
350                                        ! 3 is VECTORED EDGE
360    Num_times=2                         ! Drop star criteria to 2 tries
370    Tak_dat_flag=0                      ! Take data ON/OFF to OFF
380    Data_count=0                        ! Used for writing star data to file
390    Max_dat=100                         ! Maximum number of data sets per file
400    Max_num_files=0                     ! Initialize file counter to zero
410    Max_files=5                         ! Maximum number of data files
420    Nfiles=0                            ! For creating sequential data file names
430    File_string$="FILE_"                ! String used to create data file name
440    Disk_string$=":HP82901,700,1"       ! Defines right disk drive for data storage
450    Hour=0                              ! Variable used to time data
460    Minute=0                            !
470    Second=0                            !
480    Time_flag=0                         !
490    Inv_off=128                         ! Terminal video OFF command
500    Inv_on=129                          ! Terminal inverse video command
510    Prior=0                             ! Set up priority for ON KEY commands
520    Inter_face=0                        ! Command to be sent to interface (0 No-op)
530    Menu_flag=0                         ! Used to determine where errors come from
540    Ctrl=3                              ! Variable for control register
550    CONTROL 12,2;Ctrl                   ! Define CTRL0=0 (inverted)
```

```
560                                        !            CTRL1=0 (inverted)
570    Data_toggle$=CHR$(92)               ! Display character to show update interval
s
580    Clear$=CHR$(255)&CHR$(75)           ! Clear screen command
590                                        !
600    Auto_flag$="ON/OFF/"&CHR$(Inv_on)&"AUTO"&CHR$(Inv_off)
610    Off_flag$="ON/"&CHR$(Inv_on)&"OFF"&CHR$(Inv_off)
620    On_flag$=CHR$(Inv_on)&"ON"&CHR$(Inv_off)&"/OFF"
630                                        !
640    GOSUB Set_up_table                  ! Set up command values in CTBLE
650    OFF KEY
660    !
670    !      **********************
680    !      *      Menu1_start     *
690    !      **********************
700    !
710    !      Set up ON KEY, and screen stuff...
720    !
730  Menu1_start:                          !
740    Prior=Prior+1
750    ON KEY 0 LABEL "Redisplay",Prior GOSUB Re_display
760    ON KEY 1 LABEL "Self Test",Prior GOSUB Self_test
770    ON KEY 2 LABEL "Star Disable",Prior GOSUB Star_disable
780    ON KEY 3 LABEL "Star Enable",Prior GOSUB Star_enable
790    ON KEY 4 LABEL "Adaptive Rate",Prior GOSUB Adapt_rate
800    ON KEY 5 LABEL "Acquisition",Prior GOSUB Acquisition
810    ON KEY 6 LABEL "Take Data",Prior GOSUB Take_data
820    ON KEY 7 LABEL "Menu 2 Options",Prior GOSUB Menu2_start
830    ON KEY 8 LABEL "Tracker Status",Prior GOSUB Get_status
840    ON KEY 9 LABEL "Exit",Prior GOTO Shutdown
850    PRINTER IS 1
860    CONTROL 1;1,1
870    OUTPUT 2;Clear$;                    ! Clear the terminal screen
880    GOSUB Chk_flgs_men1                 ! Set up initial flag conditions
890    !
900    !      **********************
910    !      *      Menu1           *
920    !      **********************
930    !
940  Menu1:                                !
950    Menu_flag=1
960    CONTROL 1;26,1
970    PRINT "TRACKER COMMAND MENU #1"
980    CONTROL 1;25,3
990    PRINT "k0   Re-display Screen"
1000   CONTROL 1;25,4
1010   PRINT "k1   Self Test"
1020   CONTROL 1;25,5
1030   PRINT "k2   Star Disable"
1040   CONTROL 1;25,6
1050   PRINT "k3   Star Enable "
1060   CONTROL 1;25,7
1070   PRINT "k4   Adaptive Rate"
1080   CONTROL 1;25,8
1090   PRINT "k5   Acquisition"
1100   CONTROL 1;25,9
1110   PRINT "k6   Take Data"
1120   CONTROL 1;25,10
1130   PRINT "k7   Menu #2 Options"
1140   CONTROL 1;25,11
```

```
1150  PRINT "k8   Get Tracker Status"
1160  CONTROL 1;25,12
1170  PRINT "k9   Exit Program"
1180  CONTROL 1;1,14
1190  OUTPUT 1 USING "3(11X,10A,/)";"Star #1    ","Star #2    ","Star #3    "
1200  CONTROL 1;12,18
1210  PRINT "Current Star # ";Curr_star;"    X= ";X_posn;"    Y= ";Y_posn;"    Star
Acqu tries";Num_times
1220  STATUS 12,5;Tkr_status                    ! Get status from tracker
1230  Tkr_command=BINAND(Tkr_status,3)+10
1240  IF Test_flag=1 THEN Tkr_command=12        ! If we aren't using the interface
1250  SELECT Tkr_command                        !   else, determine what to do now
1260  CASE 10
1270    GOSUB Get_data
1280    GOSUB Trans_error
1290  CASE 11
1300    GOSUB Trans_error
1310  CASE 12
1320    GOSUB Get_data
1330  END SELECT
1340  GOSUB Chk_flgs_men1                   ! Check the status of all flags, etc...
1350  GOTO Menu1                            ! Loop in Menu 1 options
1360  !
1370  !      ***********************
1380  !      *     Menu2_start     *
1390  !      ***********************
1400  !
1410 Menu2_start:                           !
1420  Prior=Prior+1
1430  ON KEY 0 LABEL "Redisplay",Prior GOSUB Re_display
1440  ON KEY 1 LABEL "Track @ X,Y",Prior GOSUB Track_it
1450  ON KEY 2 LABEL "Drop Criteria",Prior GOSUB Drop_criteria
1450  ON KEY 3 LABEL "X Position",Prior GOSUB Set_x
1470  ON KEY 4 LABEL "Y Position",Prior GOSUB Set_y
1480  ON KEY 5 LABEL "Current Star",Prior GOSUB Set_star
1490  ON KEY 6 LABEL "Take Data",Prior GOSUB Take_data
1500  ON KEY 7 LABEL "Menu 1 Options",Prior GOSUB Menu1_start
1510  ON KEY 8 LABEL "Tracker Status",Prior GOSUB Get_status
1520  ON KEY 9 LABEL "Exit Program",Prior GOTO Shutdown
1530  CONTROL 1;1,1
1540  OUTPUT 2;Clear$;
1550  !
1560  !      ***********************
1570  !      *     Menu2           *
1580  !      ***********************
1590  !
1600 Menu2:                                           !
1610  Menu_flag=2
1620  CONTROL 1;26,1
1630  PRINT "TRACKER COMMAND MENU #2"
1640  CONTROL 1;25,3
1650  PRINT "k0   Re-display Screen"
1660  CONTROL 1;25,4
1670  PRINT "k1   Track Current Star at X, Y"
1680  CONTROL 1;25,5
1690  PRINT "k2   Set Drop Star Criteria     [";Num_times;"]    "
1700  CONTROL 1;25,6
1710  PRINT "k3   Set X Position             [";X_posn;"]       "
1720  CONTROL 1;25,7
1730  PRINT "k4   Set Y Position             [";Y_posn;"]       "
```

```
1740  CONTROL 1:25,8
1750  PRINT "k5   Set Star Number                [";Curr_star;"]    "
1760  CONTROL 1:25,9
1770  PRINT "k6   Take Data"
1780  CONTROL 1:25,10
1790  PRINT "k7   Menu #1 Options"
1800  CONTROL 1:25,11
1810  PRINT "k8   Get Tracker Status"
1820  CONTROL 1:25,12
1830  PRINT "k9   Exit Program"
1840  CONTROL 1:1,14
1850  OUTPUT 1 USING "3(11X,10A,/)":"Star #1   ","Star #2   ","Star #3   "
1860                                           !
1870  STATUS 12,5;Tkr_status                   ! Get tracker status
1880  Tkr_command=BINAND(Tkr_status,3)+10      ! Form command
1890  IF Test_flag=1 THEN Tkr_command=12       ! If we aren't using the Interface
1900  SELECT Tkr_command                       !  else decide what to do now
1910  CASE 10
1920    GOSUB Get_data
1930    GOSUB Trans_error
1940  CASE 11
1950    GOSUB Trans_error
1960  CASE 12
1970    GOSUB Get_data
1980  END SELECT
1990  GOSUB Check_data               ! Check the condition of data taking flag
2000  GOTO Menu2                     ! Loop in Menu 2 Options
2010  !
2020  STOP
2030  !****************************************
2040  !*********** Program Subroutines *******
2050  !****************************************
2060  !
2070  !      **********************
2080  !      *      Re_display     *
2090  !      **********************
2100  !
2110  !      Redisplay the current screen
2120  !
2130 Re_display:                               !
2140  IF Menu_flag=1 THEN GOSUB Menu1_start    ! We we.e in Menu 1
2150  IF Menu_flag=2 THEN GOSUB Menu2_start    ! We were in Menu 2
2160  RETURN
2170  !
2180  !      **********************
2190  !      *     Chk_flgs_men1   *
2200  !      **********************
2210  !
2220  !      This routine will display all flags
2230  !      and conditions, for variables in Menu1.
2240  !
2250 Chk_flgs_men1:                ! Check the status of...
2260  GOSUB Chk_self_tst            !     Self Test Flag
2270  GOSUB Check_stars             !     Individual Star Enable/Disable conditions
2280  GOSUB Check_adapt             !     Adaptive Rate Flag
2290  GOSUB Check_acqu              !     Acquisition Flag
2300  GOSUB Check_data              !     Data taking Flag
2310  RETURN
2320  !
2330  !      **********************
```

```
2340 !      *     Chk_self_tst     *
2350 !      **********************
2360 !
2370 !      This routine will check and display the
2380 !      STATUS of the SELF TEST FLAG.
2390 !
2400 Chk_self_tst:                   !
2410    CONTROL 1;40,4               ! Position cursor at SELF_TEST_FLAG location
2420    SELECT Self_test_flag        ! Now determine self test condition
2430    CASE 0                       ! If Self test is OFF,
2440       Disp_flag$=Off_flag$      !    then display OFF flag
2450    CASE 1                       ! If Self test is ON,
2460       Disp_flag$=On_flag$       !    then display ON flag
2470    END SELECT
2480    PRINT Disp_flag$             ! Display the flag
2490    RETURN
2500 !
2510 !      **********************
2520 !      *     Check_stars      *
2530 !      **********************
2540 !
2550 !      This routine will check and display
2560 !      the STATUS (enable/disable) OF THE STARS.
2570 !
2580 Check_stars:                      !
2590  CONTROL 1;46,5                   ! Position cursor for Star #1
2600  SELECT Star1_flag                ! Check Star #1 condition
2610  CASE 0                           ! If Star #1 is disabled,
2620    PRINT "1 "                     !    then display Star #1 as disabled
2630    CONTROL 1;46,6                 !    and clear enable display for Star #1
2640    PRINT "  "                     !
2650  CASE 1                           ! If Star #1 is enabled,
2660    PRINT "  "                     !    then clear disable display for Star #1
2670    CONTROL 1;46,6                 !    and display Star #1 as enabled
2680    PRINT "1 "                     !
2690  END SELECT                       ! End of Star #1 condition check...
2700  CONTROL 1;48,5                   ! Position cursor for Star #2
2710  SELECT Star2_flag                ! Check Star #2 condition
2720  CASE 0                           ! If Star #2 is disabled,
2730    PRINT "2 "                     !    then display Star #2 as disabled
2740    CONTROL 1;48,6                 !    and clear enable display for Star #2
2750    PRINT "  "                     !
2760  CASE 1                           ! If Star #2 is enabled,
2770    PRINT "  "                     !    then clear disable display for Star #2
2780    CONTROL 1;48,6                 !    and display Star #2 as enabled
2790    PRINT "2 "                     !
2800  END SELECT                       ! End of Star #2 condition check...
2810  CONTROL 1;50,5                   ! Position cursor for Star #3
2820  SELECT Star3_flag                ! Check Star #3 condition
2830  CASE 0                           ! If Star #3 is disabled,
2840    PRINT "3 "                     !    then display Star #3 as disabled
2850    CONTROL 1;50,6                 !    and clear enable display for Star #3
2860    PRINT "  "                     !
2870  CASE 1                           ! If Star #3 is enabled,
2880    PRINT "  "                     !    then clear disable display for Star #3
2890    CONTROL 1;50,6                 !    and display STar #3 as enabled
2900    PRINT "3 "                     !
2910  END SELECT                       ! End of Star #3 condition check...
2920  RETURN                           ! DONE !!
2930 !
```

```
2940  !      ***********************
2950  !      *     Check_adapt       *
2960  !      ***********************
2970  !
2980  !      This routine will check and display
2990  !      the STATUS of the ADAPTIVE RATE FLAG.
3000  !
3010 Check_adapt:                    !
3020  CONTROL 1:44,7                 ! Postion cursor for ADAPT_RATE_FLAG
3030  SELECT Adapt_rate_flag         ! Check condition of the adaptive rate flag
3040  CASE 0                         ! If Adaptive rate is OFF,
3050    Disp_flag$=Off_flag$         !    then display the OFF condition
3060  CASE 1                         ! If Adaptive rate is ON,
3070    Disp_flag$=On_flag$          !    then display the ON condition
3080  END SELECT
3090  PRINT Disp_flag$
3100  RETURN
3110  !
3120  !      ***********************
3130  !      *     Check_acqu        *
3140  !      ***********************
3150  !
3160  !      This routine will check and display
3170  !      the STATUS of the ACQUISITION FLAG.
3180  !      0 is OFF, 1 is ON, 2 is AUTO.
3190  !
3200 Check_acqu:                     !
3210  CONTROL 1:42,8                 ! Position cursor for ACQU_FLAG
3220  SELECT Acqu_flag               ! Check the status of the Acquisition Flag
3230  CASE 0                                     ! If Acquisition is OFF,
3240    Disp_flag$="MANUAL"                      !    then display the OFF condition
3250    IF Acqu_type=0 THEN Disp_flag2$="OFF"
3260    IF Acqu_type=1 THEN Disp_flag2$="FULL FOV "
3270    IF Acqu_type=2 THEN Disp_flag2$="FULL EDGE"
3280    IF Acqu_type=3 THEN Disp_flag2$="VEC EDGE "
3290  CASE 1                                     ! If Acquisition is ON
3300    Disp_flag$="AUTO"                        !    then display the ON condition
3310    Disp_flag2$="                 "
3320  END SELECT                                 !
3330  PRINT Disp_flag$;" ";Disp_flag2$                ! Display the flags
3340  RETURN
3350  !
3360  !      ***********************
3370  !      *     Check_data        *
3380  !      ***********************
3390  !
3400  !      This routine will check and display
3410  !      the STATUS of the DATA TAKING FLAG.
3420  !
3430 Check_data:                     !
3440  CONTROL 1:40,9                 ! Position cursor for TAK_DATA_FLAG
3450  SELECT Tak_data_flag           ! Check status of the data taking flag
3460  CASE 0                         ! If Data taking is OFF,
3470    Disp_flag$=Off_flag$         !   then display the OFF condition
3480    PRINT Disp_flag$;"                        "     ! Clear file number area
3490  CASE 1                         ! If Data taking is ON
3500    Disp_flag$=On_flag$          !   then display the ON condition
3510    PRINT Disp_flag$
3520  END SELECT
3530  RETURN
```

```
3540  !
3550  !     **********************
3560  !     *     Menu1 Options    *
3570  !     **********************
3580  !
3590  !     **********************
3600  !     *     Self_test        *
3610  !     **********************
3620  !
3630  !     This routine will TOGGLE the SELF TEST
3640  !     FLAG and set up the variables needed to send
3650  !     commands to the tracker interface.
3660  !
3670 Self_test:                     !
3680  DISABLE                       ! Disable all interrupts from ON KEY commands
3690                                ! Toggle the SELF TEST FLAG
3700  Self_test_flag=1-Self_test_flag
3710  GOSUB Chk_self_tst            ! Display the NEW condition
3720                                !
3730  Inter_face=224                ! Set up command for SELF TEST
3740                                !    and send message
3750                                !
3760  Send_msg$="Self Test "&Disp_flag$&" Command"
3770                                !
3780                                !
3790  GOSUB Cmd_interface           ! Output command to interface box
3800  ENABLE                        ! Enable interrupts for ON KEY commands
3810  RETURN
3820  !
3830  !     **********************
3840  !     *     Star_disable     *
3850  !     **********************
3860  !
3870  !     This routine will DISABLE the CURRENT STAR,
3880  !     and change the star flag to show such status.
3890  !
3900 Star_disable:               !
3910  DISABLE                    ! Disable all interrupts from the ON KEY commands
3920                                         ! Is current star ...
3930  IF Curr_star=1 THEN Star1_flag=0       !      #1 ??
3940  IF Curr_star=2 THEN Star2_flag=0       !      #2 ??
3950  IF Curr_star=3 THEN Star3_flag=0       !      #3 ??
3960  GOSUB Check_stars                      ! Display NEW condition
3970                                         !
3980  Inter_face=152                         ! Set up command for disable star
3990  Send_msg$="Star Disable Command"       !  and send message
4000  GOSUB Cmd_interface                    ! Output command to interface box
4010  Inter_face=Ctble(Curr_star)            ! Set up command to reflect star #
4020  Send_msg$="Star #"&VAL$(Curr_star)     !    and send message
4030  GOSUB Cmd_interface                    ! Output star # to interface
4040  ENABLE                          ! Enable all interrupts for ON KEY commands
4050  RETURN
4060  !
4070  !     **********************
4080  !     *     Star_enable      *
4090  !     **********************
4100  !
4110  !     This routine will ENABLE the CURRENT STAR,
4120  !     and change the star flag to show such status.
4130  !
```

```
4140 Star_enable:               !
4150  DISABLE                   ! Disable all interrupts from the ON KEY commands
4160                                          ! Is current star ...
4170  IF Curr_star=1 THEN Star1_flag=1        !      #1 ??
4180  IF Curr_star=2 THEN Star2_flag=1        !      #2 ??
4190  IF Curr_star=3 THEN Star3_flag=1        !      #3 ??
4200  GOSUB Check_stars                       ! Display NEW condition
4210                                          !
4220  Inter_face=120                          ! Set up command for star enable
4230  Send_msg$="Star Enable Command"         !   and send message
4240  GOSUB Cmd_interface                     ! Output command to interface
4250  Inter_face=Ctble(Curr_star)             ! Set up command to reflect star #
4260  Send_msg$="Star #"&VAL$(Curr_star)      !   and send message
4270  GOSUB Cmd_interface                     ! Output star # to interface
4280  ENABLE                          ! Enable all interrupts for ON KEY commands
4290  RETURN
4300  !
4310  !     ***********************
4320  !     *     Adapt_rate      *
4330  !     ***********************
4340  !
4350  !     This routine will TOGGLE the ADAPTIVE RATE FLAG,
4360  !     between ON/OFF, and also set up the correct command
4370  !     to be sent to the tracker interface.
4380  !
4390 Adapt_rate:                    !
4400  DISABLE                       ! Disable all interrupts from ON KEY commands
4410  Adapt_rate_flag=1-Adapt_rate_flag   ! Toggle the adaptive rate flag
4420  GOSUB Check_adapt                   ! Display NEW condition
4430                                      ! Set up send message
4440                                      !   and Adaptive Rate command
4450                                      !
4460  Send_msg$="Adaptive Rate "&Disp_flag$&" Command"
4470  Inter_face=180                      !
4480                                      !
4490  GOSUB Cmd_interface                 ! Output command to interface
4500  ENABLE                          ! Enable all interrupts for ON KEY commands
4510  RETURN
4520  !
4530  !     ***********************
4540  !     *     Acquisition     *
4550  !     ***********************
4560  !
4570  !     This routine will TOGGLE the ACQUISITION FLAG
4580  !     between ON/OFF/AUTO, and also set up the correct command
4590  !     to be sent to the tracker interface. 0 is OFF, 1 is ON,
4600  !     2 is AUTO.
4610  !
4620 Acquisition:                   !
4630  DISABLE                       ! Disable all interrupts from ON KEY commands
4640  Acqu_flag=1-Acqu_flag               ! Change the acquistion flag
4650  GOSUB Check_acqu                    ! Display the NEW condition
4660                                      ! Set up send message
4670                                      !  and command for Acquisition
4680                                      !
4690  IF Acqu_flag=0 THEN
4700     BEEP
4710     INPUT "Please input Acquisition type: 0=OFF, 1=FULL FOV,2=FULL EDGE, 3=
VEC EDGE",Acqu_type
4720        IF Acqu_type>-1 AND Acqu_type<4 THEN Send_acqu
```

```
4730           BEEP
4740           DISP "INVALID acquisition type ";Acqu_type;" press <CONT> to try
again"
4750           PAUSE
4760           GOTO 4710
4770  END IF
4780 Send_acqu: !
4790  Send_msg$="Acquisition "&Auto_disp_flag$&" Command"
4800  Inter_face=204                              !
4810  GOSUB Cmd_interface                         ! Output command to interface
4820  ENABLE                                  ! Enable all interrupts for ON KEY commands
4830  RETURN
4840  !
4850  !      **********************
4860  !      *     Take_data      *
4870  !      **********************
4880  !
4890  !      This routine will TOGGLE the DATA TAKING FLAG,
4900  !      between ON/OFF, no command is sent to the interface
4910  !      but some variables associated with the process
4920  !      must be set.
4930  !
4940 Take_data:                             !
4950  DISABLE                               ! Disable all interrupts from ON KEY commands
4960  Tak_data_flag=1-Tak_data_flag             ! Toggle the data taking flag
4970  GOSUB Check_data                          ! Display the NEW condition
4980                                            ! If we aren't taking data then DONE
4990  IF Tak_data_flag=0 THEN Take_data_end
5000  Data_count=0                              ! Else re-set the data set counter
5010  Max_num_files=Nfiles+Max_files            ! Increment the max number of files
5020  IF Nfiles<=Max_num_files THEN             ! If we haven't exceeded our limit
5030    PRINTER IS 1                            !
5040    IF Nfiles=0 THEN                        ! If we haven't input a starting file #
5050      BEEP
5060      DISP
5070      INPUT "Please input initial data file # >",Nfiles
5080                                                !
5090      IF Nfiles>=0 AND Nfiles<=99 THEN          ! Check input for validity
5100        Max_num_files=Max_files+Nfiles
5110      ELSE
5120        BEEP
5130        DISP
5140        DISP "INVALID file # ";Nfiles:", press <CONT> to try again!"
5150        PAUSE
5160        DISP
5170        GOTO 5070                               ! Input file number again...
5180      END IF
5190    END IF
5200 Take_data_end:                                 !
5210                                                ! Write residual data to the file
5220    IF Data_count>0 THEN GOSUB Write_data
5230                                                !
5240    ENABLE                       ! Enable all interrupts for the ON KEY commands
5250    RETURN
5260  !
5270  !      **********************
5280  !      *    Menu2 Options   *
5290  !      **********************
5300  !
5310  !      **********************
```

```
5320  !      *     Track_it         *
5330  !      ***********************
5340  !
5350  !      This routine will set up variables for the
5360  !      COMMANDED TO TRACK POSITION, it will use the
5370  !      CURRENT STAR #, X POSITION, Y POSITION for
5380  !      information sent to the tracker interface.
5390  !
5400 Track_it:                      !
5410    DISABLE                     ! Disable all interrupts from ON KEY commands
5420    Inter_face=84               ! Set up commanded to track position command
5430                                !   and send message
5440    Send_msg$="Track at X, Y Command"
5450    GOSUB Cmd_interface                    ! Output Track command
5460                                           !
5470    Inter_face=Ctble(Curr_star)            ! Set up star #
5480    Send_msg$="Star #"&VAL$(Curr_star)     !   and send message
5490    GOSUB Cmd_interface                    ! Output star # to track to interface
5500                                           !
5510    Inter_face=X_posn                      ! Set up the X position
5520                                           !   and send message
5530    Send_msg$="X Position  ["&VAL$(X_posn)&"]"
5540    GOSUB Cmd_interface                    ! Output X position to interface
5550    GOSUB Cmd_interface                    !  (must output this puppy twice...)
5560                                           !
5570    Inter_face=Y_posn                      ! Set up the Y position
5580                                           !   and send message
5590    Send_msg$="Y Position  ["&VAL$(Y_posn)&"]"
5600    GOSUB Cmd_interface                    ! Output Y position to interface
5610    GOSUB Cmd_interface                    !  (must output this puppy twice)
5620                                           !
5630    ENABLE                      ! Enable all interrupts for ON KEY commands
5640    RETURN
5650  !
5660  !      ***********************
5670  !      *     Drop_criteria    *
5680  !      ***********************
5690  !
5700  !      This routine will query the user for the DROP
5710  !      CRITERIA which is currently defines as the number of times
5720  !      the tracker will try and track the star before it is dropped,
5730  !      it will also set up the correct command to be sent to
5740  !      the tracker interface.
5750  !
5760 Drop_criteria:                 !
5770    DISABLE                     ! Disable all interrupts from ON KEY commands
5780    DISP                        ! Clear the display line
5790    BEEP
5800    INPUT "Please input the new drop criteria  >",Num_times
5810    IF Num_times>0 AND Num_times<=15 THEN End_criteria
5820    BEEP
5830    DISP "INVALID drop criteria ";Num_times;", press <CONT> to try again!"
5840    PAUSE
5850    GOTO Drop_criteria                        ! Let the user try again...
5860 End_criteria:                                !
5870    Send_msg$="Drop Criteria Command"         ! Set up send message
5880    Inter_face=44                             !  and Drop criteria command
5890    GOSUB Cmd_interface                       ! Output command to interface
5900                                              !
5910                                              ! Set up send message
```

```
5920    Inter_face=Ctble(Num_times)           !    and drop criteria data
5930    Send_msg$="Drop Criteria Data   ["&VAL$(Num_times)&"]"
5940                                          !
5950    GOSUB Cmd_interface                   ! Output command to interface
5960    ENABLE                             ! Enable all interrupts for ON KEY commands
5970    RETURN
5980  !
5990  !      **********************
6000  !      *      Set_X         *
6010  !      **********************
6020  !
6030  !      This routine will query the user for the new X
6040  !      POSITION.
6050  !
6060 Set_x:                                                 !
6070    DISP                                                ! Clear the display line
6080    BEEP
6090    INPUT "Please input the new X position",X_posn
6100                                                        ! Check input for validity
6110    IF X_posn>-1 AND X_posn<257 THEN End_set_x
6120    BEEP
6130    DISP "INVALID X position ";X_posn;" press <CONT> to try again!"
6140    PAUSE
6150    GOTO Set_x                                          ! Let the user try again
6160 End_set_x:                                             !
6170    RETURN
6180  !
6190  !      **********************
6200  !      *      Set_Y         *
6210  !      **********************
6220  !
6230  !      This routine will query the user for the new Y
6240  !      POSITION.
6250  !
6260 Set_y:!
6270    DISP                                                ! Clear the display line
6280    BEEP
6290    INPUT "Please input the new Y position".Y_posn
6300                                                        ! Check input for validity
6310    IF Y_posn>-1 AND Y_posn<257 THEN End_set_y
6320      BEEP
6330      DISP "INVALID Y position ";Y_posn;" press <CONT> to try again!"
6340      PAUSE
6350      GOTO Set_y                                        ! Let the user try again
6360 End_set_y:                                             !
6370    RETURN
6380  !
6390  !      **********************
6400  !      *      Set_star      *
6410  !      **********************
6420  !
6430  !      This routine will query the user for the NEW
6440  !      STAR NUMBER.
6450  !
6460 Set_star:!
6470    DISP                                                ! Clear the display line
6480    BEEP
6490    INPUT "Please input the new star number",Curr_star
6500                                                        ! Check input for validity
6510    IF Curr_star>0 AND Curr_star<4 THEN End_set_star
```

```
6520        BEEP
6530        DISP "INVALID star number ";Curr_star;" press <CONT> to try again!"
6540        PAUSE
6550        GOTO Set_star                                  ! Let them try again...
6560 End_set_star:                                        !
6570     RETURN
6580  !
6590  !      **********************
6600  !      *     Get_status     *
6610  !      **********************
6620  !
6630  !      This routine will output the GET STATUS
6640  !      command to the interface, and will then
6650  !      check the each of the individual condition
6660  !      flags that will be recieved from the interface.
6670  !
6680 Get_status:                        !
6690  DISABLE                           ! Disable all interrupts from ON KEY commands
6700                                    ! Set up the send message
6710  Inter_face=210                    !   and Get status command
6720  Send_msg$="Get Status Command"
6730                                    !
6740  GOSUB Cmd_interface               ! Output command to the interface
6750  IF Test_flag=0 THEN               ! If we ARE using the interface box then...
6760    Ctrl=BINAND(1,Ctrl)
6770    CONTROL 12,2;Ctrl               ! Get the status data from the interface
6780    WAIT .1
6790    ENTER 12 USING "3(#,W)";Status1,Status2,Status3
6800    ENTER 12 USING "3(#,W)";Status4,Status5,Status6
6810    ENTER 12 USING "3(#,W)";Status7,Status8,Status9
6820    IF (Status1=Status4) AND (Status4=Status7) THEN  ! Make sure they are of
        IF STATUS1=0 THEN 6900
6830      IF Status1<0 THEN Status1=65536+Status1
6840 !    Status1=Status1/256           ! Convert these values to decimal
6850      CONTROL 1;22,14
6860      PRINT USING "#,10A,K";" Status= ";Status1
6870      PAUSE
6880      Star1_flag=BIT(Status1,15)
6890      Star2_flag=BIT(Status1,14)                  ! Now change flags according
6900      Star3_flag=BIT(Status1,13)                  !  to the actual conditions
6910      Track1_flag=BIT(Status1,12)                 !  of the tracker...
6920      Track2_flag=BIT(Status1,11)
6930      Track3_flag=BIT(Status1,10)
6940      Pt1=BIT(Status1,9)
6950      Pt2=BIT(Status1,8)
6960      Acqu_flag=Pt1+Pt2
6970      Self_test_flag=BIT(Status1,7)
6980      Pt1=BIT(Status1,4)
6990      Pt2=BIT(Status1,3)
7000      Pt3=BIT(Status1,2)
7010      Pt4=BIT(Status1,1)
7020      Num_times=(Pt1*8)+(Pt2*4)+(Pt3*2)+Pt1
7030    END IF
7040  END IF
7050  ENABLE                          ! Enable all interrupts for the ON KEY commands
7060  RETURN
7070  !
7080  !
7090  !      **********************
7100  !      *    Cmd_interface   *
```

```
7110  !      ************************
7120  !
7130  !      This routine will output a specific command
7140  !      stored in variable INTER_FACE, to the interface box.
7150  !      while it is "waiting" for the acknowledge signal
7160  !      it will concurrently collect data from the tracker.
7170  !
7180 Cmd_interface:!
7190    Menu_flag=3
7200    Ctrl=2                  ! Set dir=OUT CTL1=1
7210    CONTROL 12,2;Ctrl       ! Command ready CTL0=1
7220    WAIT .1                 ! Wait for uP to recover from reset
7230    Ctrl=BINIOR(1,Ctrl) ! CTL0 pulsed down, set low when in normal operation
7240    CONTROL 12,2;Ctrl
7250    DISP
7260    DISP "Sending ";Send_msg$;" to tracker..."
7270 !  DISP "Sending ";Send_msg$;" to tracker...PRESS STEP, CONT,ETC"
7280 !  PAUSE
7290    IF Test_flag=1 THEN
7300       WAIT .5
7310       DISP
7320       RETURN
7330    END IF
7340    OUTPUT 12 USING "#,B";Inter_face   ! Output command to interface
7350    Time_out=(TIMEDATE) MOD 86400      ! Must wait for 7 seconds for
7360    Time_out=Time_out+7                ! interface, collect data while
7370    Time_out1=Time_out+1 MOD 60        ! waiting...
7380    Time_flag=0                        ! It isn't time yet...
7390 Do_it_again:                          !
7400    Time_yet=TIMEDATE MOD 86400        ! Check current time
7410    IF (Time_out>Time_out1) THEN
7420      IF (Time_yet>Time_out) OR (Time_yet<Time_out1) THEN Time_flag=1
7430    ELSE
7440      IF (Time_yet>Time_out) AND (Time_yet<Time_out1) THEN Time_flag=1
7450    END IF
7460 Check_tracker:                       !
7470 !  DISP "Time_yet";Time_yet;" Time_out ";Time_out;" Time_out1 ";Time_out1;"
 Time_flag";Time_flag                   !  FOR DEBUGGING PURPOSES
7480    WAIT 1.0
7490    STATUS 12,5;Tkr_status
7500    Tkr_command=BINAND(Tkr_status,3)+10
7510    SELECT Tkr_command
7520    CASE 10
7530      GOSUB Get_data
7540      Ctrl=BINAND(2,Ctrl)
7550      CONTROL 12,2;Ctrl
7560      Ctrl=BINIOR(1,Ctrl)
7570      CONTROL 12,2;Ctrl
7580      GOSUB Trans_error
7590    CASE 11
7600      GOSUB Trans_error
7610    CASE 12
7620      GOSUB Get_data
7630    END SELECT
7640    IF Time_flag=2 THEN
7650       DISP
7660       RETURN
7670    END IF
7680    IF Time_flag=0 THEN GOTO Do_it_again      ! Not time yet...
7690    IF Time_flag=1 THEN Time_flag=2           ! Check status one more time...
```

```
7700    GOTO Check_tracker
7710  !
7720  !     ***********************
7730  !     *     Get_data        *
7740  !     ***********************
7750  !
7760  !     This routine will RECIEVE and DISPLAY
7770  !     STAR DATA from the interface box.
7780  !
7790 Get_data:                 !
7800    DISABLE                ! Disable all interrupts from the ON KEY commands
7810    IF Test_flag=0 THEN    ! If we ARE using the interface box then...
7820      Ctrl=BINAND(1,Ctrl)  !    Get star data from the tracker
7830      CONTROL 12,2;Ctrl
7840      ENTER 12 USING "3(#,W)";Star1_x,Star1_y,Star1_m
7850      ENTER 12 USING "3(#,W)";Star2_x,Star2_y,Star2_m
7860      ENTER 12 USING "3(#,W)";Star3_x,Star3_y,Star3_m
7870                           !
7880                           ! Now check these numbers for negative values
7890                           !
7900      IF Star1_x<0 THEN Star1_x=65536+Star1_x
7910      IF Star1_y<0 THEN Star1_y=65536+Star1_y
7920      IF Star1_m<0 THEN Star1_m=65536+Star1_m
7930      IF Star2_x<0 THEN Star2_x=65536+Star2_x
7940      IF Star2_y<0 THEN Star2_y=65536+Star2_y
7950      IF Star2_m<0 THEN Star2_m=65536+Star2_m
7960      IF Star3_x<0 THEN Star3_x=65536+Star3_x
7970      IF Star3_y<0 THEN Star3_y=65536+Star3_y
7980      IF Star3_m<0 THEN Star3_m=65536+Star3_m
7990                           !
8000      Star1_x=Star1_x/256  ! Convert these values to decimal
8010      Star1_y=Star1_y/256
8020      Star1_m=Star1_m/256
8030      Star2_x=Star2_x/256
8040      Star2_y=Star2_y/256
8050      Star2_m=Star2_m/256
8060      Star3_x=Star3_x/256
8070      Star3_y=Star3_y/256
8080      Star3_m=Star3_m/256
8090    ELSE
8100      Star1_x=11+Data_count    ! NOT using interface so set up some
8110      Star1_y=12+Data_count    !  bogus numbers for star values
8120      Star1_m=13+Data_count
8130      Star2_x=14+Data_count
8140      Star2_y=15+Data_count
8150      Star2_m=16+Data_count
8160      Star3_x=17+Data_count
8170      Star3_y=18+Data_count
8180      Star3_m=19+Data_count
8190    END IF
8200                                ! Calculate time variables
8210                                !    to be written to the data file
8220    Datat=(3600*Hour+60*Minute+Second-TIMEDATE)+ABS(Datat)
8230    Data_time=(TIMEDATE+Datat) MOD 86400
8240    Data_time=INT(Data_time*100)/100
8250    Hour=Data_time DIV 3600
8260    Minute=Data_time MOD 3600 DIV 60
8270    Second=Data_time MOD 60
8280    CONTROL 1;1,10              ! Display the update flag
8290    PRINT USING "#,1A";Data_toggle$
```

```
8300    Data_toggle$=CHR$(139-NUM(Data_toggle$))
8310                                        !
8320                                        ! Display the star values being recieved
8330    CONTROL 1;22,14                     ! from the tracker...
8340    PRINT USING "#,4A,4D.4D";" X=";Star1_x
8350    PRINT USING "#,4A,4D.4D";" Y=";Star1_y
8360    PRINT USING "#,4A,4D.4D";" M=";Star1_m
8370    CONTROL 1;22,15
8380    PRINT USING "#,4A,4D.4D";" X=";Star2_x
8390    PRINT USING "#,4A,4D.4D";" Y=";Star2_y
8400    PRINT USING "#,4A,4D.4D";" M=";Star2_m
8410    CONTROL 1;22,16
8420    PRINT USING "#,4A,4D.4D";" X=";Star3_x
8430    PRINT USING "#,4A,4D.4D";" Y=";Star3_y
8440    PRINT USING "#,4A,4D.4D";" M=";Star3_m
8450                                                   !
8460    IF Tak_data_flag=0 THEN End_get_data   ! If NOT taking data then DONE
8470    Data_count=Data_count+1                        ! ELSE,
8480    IF Data_count<=Max_dat THEN
8490      Star_data(Data_count,1)=Star1_x      ! Load star data into array
8500      Star_data(Data_count,2)=Star1_y      !  for writing data to file...
8510      Star_data(Data_count,3)=Star1_m
8520      Star_data(Data_count,4)=Star2_x
8530      Star_data(Data_count,5)=Star2_y
8540      Star_data(Data_count,6)=Star2_m
8550      Star_data(Data_count,7)=Star3_x
8560      Star_data(Data_count,8)=Star3_y
8570      Star_data(Data_count,9)=Star3_m
8580      Star_data(Data_count,10)=Hour
8590      Star_data(Data_count,11)=Minute
8600      Star_data(Data_count,12)=Second
8610      CONTROL 1;48,9
8620      IF Data_count>0 THEN PRINT Data_count        ! Display data count
8630      IF Data_count=0 THEN PRINT "               " ! Else clear count area
8640    END IF
8650    END IF
8660    IF Data_count=Max_dat THEN GOSUB Write_data    ! If array is full
8670                                                   ! then write it out
8680 End_get_data:                                     !
8690    ENABLE                       ! Enable all interrupts for the ON KEY commands
8700    RETURN
8710  !
8720  !     ***********************
8730  !     *     Write_data      *
8740  !     ***********************
8750  !
8760  !     This routine will write data to the output file.
8770  !
8780 Write_data:                          !
8790  ON ERROR GOTO Error_tst             ! Trap errors that occur when writing data
8800  Number$=VAL$(Nfiles)
8810  File_string$[6]=Number$[1]          ! Create a file name to be used
8820  DISP                                ! Clear display line
8830                                      ! Let the user know what file we are using
8840  DISP "Writing data to >";File_string$
8850                                      ! Designate the right disk drive for data
8860  MASS STORAGE IS ":HP82901,700,1"
8870  CREATE BDAT File_string$,Max_dat ! Open the data file
8880  ASSIGN @Path_1 TO File_string$
8890  OUTPUT @Path_1;Star_data(*)         ! Write data to the file
```

```
8900  ASSIGN @Path_1 TO *                ! Close the data file
8910  Nfiles=Nfiles+1                    ! Increment file name variable
8920  Data_count=0              ! Initialize data set counter for another round !!
8930  OFF ERROR
8940  DISP                               ! Clear the display line
8950  RETURN
8960  !
8970  !     **********************
8980  !     *     Error_tst      *
8990  !     **********************
9000  !
9010  !     This routine will trap any error's encountered
9020  !     in the data taking process.
9030  !
9040 Error_tst:                           !
9050  BEEP                                ! Beep 'em ...
9060  OFF ERROR
9070  IF ERRN=54 THEN                     ! Duplicate file name error code
9080    DISP
9090    DISP "This file already exists, press <CONT> to try again!"
9100    PAUSE
9110    DISP
9120    INPUT "Please input initial file # >",Nfiles   ! try again...
9130                                       ! Check input for validity
9140    IF Nfiles>0 AND Nfiles<99 THEN
9150      Max_num_files=Max_files+Nfiles
9160      GOTO Write_data                  ! Input was OK, now write the data
9170    END IF
9180  ELSE
9190    IF ERRN=64 THEN                    ! Mass storage overflow error code
9200      DISP
9210      DISP "The data disc is full, Please exchange it with a new one..."
9220      WAIT .5
9230      DISP "Press <CONT> after replacing the disc to continue!"
9240      PAUSE
9250      DISP
9260      GOTO Write_data       ! Hopefully the data disc was replaced correctly
9270    ELSE
9280       IF ERRN=80 THEN      ! Disc NOT changed or not IN right drive...
9290          DISP
9300          DISP "There is not a correct disc in the right disk drive..."
9310          WAIT .5
9320          DISP "Press <CONT> after placing disc in the right hand drive"
9330          PAUSE
9340          DISP
9350          GOTO Write_data
9360      ELSE
9370                         ! There was a different error, must look up and correct
9380                         ! the problem before continuing...
9390          DISP
9400          DISP "Unexpected error (";ERRN;") press <CONT> after correcting pr
oblem"
9410          PAUSE
9420          DISP
9430      END IF
9440    END IF
9450  END IF
9460  RETURN
9470  !
9480  !     **********************
```

```
9490  !      *       Trans_error       *
9500  !      ***********************
9510  !
9520  !      This routine will display a message, and beep at you
9530  !      if there was a transmit error. By using the Menu_flag
9540  !      to determine where the error came from, a message will
9550  !      be displayed.
9560  !
9570 Trans_error: !
9580  IF Menu_flag=0 THEN Err_msg$="                           "
9590  IF Menu_flag=1 THEN Err_msg$=" Menu1 Xmit Error           "
9600  IF Menu_flag=2 THEN Err_msg$=" Menu2 Xmit Error           "
9610  IF Menu_flag=3 THEN Err_msg$=" Command Interface Xmit Error"
9620  DISP
9630  DISP Err_msg$               ! Let the user know where the error came from...
9640                              !
9650  Ctrl=BINAND(2,Ctrl)
9660  CONTROL 12,2:Ctrl
9670  Ctrl=BINIOR(1,Ctrl)
9680  CONTROL 12,2:Ctrl
9690  Freq1=4000
9700  Freq2=1000
9710  Bnumber=2
9720  Btime=.2
9730  Dfreq=(Freq2-Freq1)/Bnumber-1
9740  FOR F=0 TO Bnumber-1
9750    Bfreq=Freq1+(Dfreq*F)
9760    BEEP Bfreq,Btime          ! Beep ´em...
9770    Btime=Btime*5
9780  NEXT F
9790  DISP
9800  RETURN
9810  !
9820  !      ***********************
9830  !      *      Set_up_table    *
9840  !      ***********************
9850  !
9860  !      This routine will set up values for
9870  !      a command table.
9880  !
9890 Set_up_table:                  !
9900  Ctble(1)=224                  ! Self test ON/OFF
9910  Ctble(2)=152                  ! Disable current star
9920  Ctble(3)=120                  ! Enable current star
9930  Ctble(4)=84                   ! Track current star @ X, Y
9940  Ctble(5)=180                  ! Adaptive Rate ON/OFF
9950  Ctble(6)=204                  ! Acquistion ON/OFF/AUTO
9960  Ctble(7)=44                   ! Set drop star criteria
9970  Ctble(8)=210                  ! Get Tracker status
9980  Ctble(9)=50                   ! UNDEFINED as of yet
9990  Ctble(10)=74                  ! UNDEFINED as of yet
10000 Ctble(11)=172                 ! UNDEFINED as of yet
10010 Ctble(12)=136                 ! UNDEFINED as of yet
10020 Ctble(13)=102                 ! UNDEFINED as of yet
10030 Ctble(14)=30                  ! UNDEFINED as of yet
10040 Ctble(15)=254                 ! UNDEFINED as of yet
10050 RETURN
10060 !
10070 !      ***********************
10080 !      *       No_op          *
```

```
10090 !      ************************
10100 !
10110 !      This routine will be used as a no operation type
10120 !      subroutine, if the user inputs an invalid option, they
10130 !      will kicked into here, and be advised of the input error.
10140 !
10150 No_op:!
10160 BEEP
10170 Err_msg$="                "
10180 IF Menu_flag=1 THEN Err_msg$="from Menu #1 "
10190 IF Menu_flag=2 THEN Err_msg$="from Menu #2 "
10200 DISP
10210 DISP "INVALID COMMAND ENTRY..."
10220 WAIT .5
10230 DISP Err_msg$
10240 WAIT .5
10250 DISP
10260 RETURN
10270 !
10280 !      ************************
10290 !      *      Shutdown        *
10300 !      ************************
10310 !
10320 !      This is the routine which allows the user
10330 !      to EXIT from the program.
10340 !
10350 Shutdown:!
10360 OFF KEY
10370 PRINTER IS 1
10380 OUTPUT 2;Clear$;
10390 PRINT
10400 PRINT "PROGRAM TERMINATED..."
10410 END
```

Section I-2

Section I-2
FLOWCHART OF THE STAR TRACKER CONTROL PROGRAM

```
+----------------+
¦     START      ¦
+-------+--------+
        ¦
+-------+--------+
¦ Dimension      ¦
¦ data arrays &  ¦
¦ string         ¦
¦ variables      ¦
+-------+--------+
        ¦
+-------+--------+
¦ Initialize     ¦
¦ variables and  ¦
¦ strings        ¦
+-------+--------+
        ¦
+-------+--------+
¦     GOSUB      ¦
¦ Set_up_table   ¦
¦   (PAGE 60)    ¦
+-------+--------+
        ¦
+-------+--------+
¦    OFF KEY     ¦
¦ turn off all   ¦
¦ previously     ¦
¦ assigned soft  ¦
¦ key functions  ¦
+-------+--------+
        ¦
+----------------+
¦****************¦
¦  MENU1_START   ¦
¦****************¦
¦                ¦
¦ Set up soft    ¦
¦ key functions  ¦
¦ for Menu #1    ¦
+-------+--------+
        ¦
+-------+--------+
¦Prior = 1+Prior ¦
+-------+--------+
        ¦
+----------------+
¦       k0       ¦
¦----------------¦
¦     GOSUB      ¦
¦   Re_display   ¦
¦                ¦
¦    (PAGE 9)    ¦
+----------------+
        .
        .
        .
        .
        .
        .
        v
```

```
                 v

     +-------------------+
     |        k1         |
     |-------------------|
     |       GOSUB       |
     |     Self_test     |
     |                   |
     |     (PAGE 17)     |
     +-------------------+
               .
               .
     +-------------------+
     |        k2         |
     |-------------------|
     |       GOSUB       |
     |    Star_disable   |
     |                   |
     |     (PAGE 18)     |
     +-------------------+
               .
               .
     +-------------------+
     |        k3         |
     |-------------------|
     |       GOSUB       |
     |    Star_enable    |
     |                   |
     |     (PAGE 20)     |
     +-------------------+
               .
               .
     +-------------------+
     |        k4         |
     |-------------------|
     |       GOSUB       |
     |     Adapt_rate    |
     |                   |
     |     (PAGE 23)     |
     +-------------------+
               .
               .
     +-------------------+
     |        k5         |
     |-------------------|
     |       GOSUB       |
     |    Acquisition    |
     |                   |
     |     (PAGE 24)     |
     +-------------------+
               .
               .
               .
               .
               .
               .
               .
               .
               .
               v
```

```
                 v

        +----------------+
        !       k6       !
        !----------------!
        !      GOSUB     !
        !    Take_data   !
        !                !
        !   (PAGE 26)    !
        +----------------+
                .
                .
        +----------------+
        !       k7       !
        !----------------!
        !      GOSUB     !
        !   Menu2_start  !
        !                !
        !   (PAGE 5)     !
        +----------------+
                .
                .
        +----------------+
        !       k8       !
        !----------------!
        !      GOSUB     !
        !   Get_status   !
        !                !
        !   (PAGE 36)    !
        +----------------+
                .
                .
        +----------------+
        !       k9       !
        !----------------!
        !      GOTO      !
        !    Shutdown    !
        !                !
        !   (PAGE 64)    !
        +-------+--------+
                !
        +-------+--------+
        ! Clear the      !
        ! screen         !
        !----------------!
        !Terminal Output !
        +-------+-------/
                !
        +-------+--------+
        !      GOSUB     !
        !Check_flgs_men1 !
        !   (PAGE 9)     !
        +-------+--------+
                !
                !
                !
                !
                !
                !
                v
```

```
                                                v
                                      +-------------------+
                                      |*******************|
                                      |       MENU1       |
                                      |*******************|
                                      |                   |
                                      | Display Menu      |
                                      | #1 options &      |
                                      | current           |
                                      | conditions        |
                                      +---------+---------+
                                                |
+---------------------------------------------->|
|                                     +---------+---------+
|                                     | Menu_flag = 1     |
|                                     +---------+---------+
|                                               |
|                                     +---------+---------+
|                                     | Display the       |
|                                     | options for       |
|                                     | Menu #1           |
|                                     |-------------------|
^                                     |Terminal Output    |
|                                     +---------+--------/
|                                               |
|                                     +---------+---------+
|                                     | Display           |
|                                     | current star      |
|                                     | values, star #    |
|                                     | X position,       |
|                                     | Y position, &     |
|                                     | # of acquisit-    |
^                                     | ion tries         |
|                                     |-------------------|
|                                     |Terminal Output    |
|                                     +---------+--------/
|                                               |
|                                  +------------+--------------+
|                                  \STATUS 12,5;Tkr_status    /
|                                   \-------------------------/
|                                    \ (Get tracker          /
|                                     | status from         |
^                                     | the interface)      |
|                                     +---------+---------+
|                                               |
|                                  +------------+--------------+
|                                  | Tkr_command =  10 +       |
|                                  | BINAND(Tkr_status,3)      |
|                                  +------------+--------------+
|                                               |
|                                     +---------+--------+
|                          case 10 /       SELECT          \  case 12
^                 +-----------------<     Tkr_command       >------------------+
|                 |                   \                    /                   |
|                 |                    +---------+--------+                    |
|                 |                              |case 11                      |
|                 |                              |                             |
|                 |                              |                             |
|                 |                              |                             |
^                 v                              v                             v
^                 v                           v                           v
:        +--------+--------+         +--------+--------+         +--------+--------+
:        :      GOSUB      :         :      GOSUB      :         :      GOSUB      :
:        :    Get_data     :         :   Trans_error   :         :    Get_data     :
:        :    (PAGE 43)    :         :    (PAGE 57)    :         :    (PAGE 43)    :
:        +--------+--------+         +--------+--------+         +--------+--------+
:                 :                           :                           :
^        +--------+--------+                  :                           :
:        :      GOSUB      :                  :                           :
:        :   Trans_error   :                  :                           :
:        :    (PAGE 57)    :                  :                           :
:        +--------+--------+                  :                           :
:                 :                           v                           :
:                 +-------------------------->:<--------------------------+
:                                    +--------+--------+
:                                    :      GOSUB      :
:                                    :Check_flgs_men1  :
^                                    :    (PAGE 9)     :
:                                    +--------+--------+
:                                             :
+-----------------<---------------------------+

                                     +-----------------+
                                     :*****************:
                                     :   MENU2_START   :
                                     :*****************:
                                     :                 :
                                     :  Set up soft    :
                                     :  key functions  :
                                     :  for Menu #2    :
                                     +--------+--------+
                                              :
                                     +--------+--------+
                                     :Prior = 1+Prior  :
                                     +--------+--------+
                                              :
                                     +--------+--------+
                                     :       k0        :
                                     :-----------------:
                                     :      GOSUB      :
                                     :   Re_display    :
                                     :                 :
                                     :    (PAGE 9)     :
                                     +-----------------+
                                              .
                                              .
                                     +-----------------+
                                     :       k1        :
                                     :-----------------:
                                     :      GOSUB      :
                                     :    Track_it     :
                                     :                 :
                                     :    (PAGE 28)    :
                                     +-----------------+
                                              .
                                              .
                                              .
                                              .
                                              .
                                              v
```

```
                v
      +----------------+
      !       k2       !
      !----------------!
      !     GOSUB      !
      ! Drop_criteria  !
      !                !
      !   (PAGE 31)    !
      +----------------+
                .
                .
      +----------------+
      !       k3       !
      !----------------!
      !     GOSUB      !
      !     Set_x      !
      !                !
      !   (PAGE 34)    !
      +----------------+
                .
                .
      +----------------+
      !       k4       !
      !----------------!
      !     GOSUB      !
      !     Set_y      !
      !                !
      !   (PAGE 35)    !
      +----------------+
                .
                .
      +----------------+
      !       k5       !
      !----------------!
      !     GOSUB      !
      !    Set_star    !
      !                !
      !   (PAGE 30)    !
      +----------------+
                .
                .
      +----------------+
      !       k6       !
      !----------------!
      !     GOSUB      !
      !   Take_data    !
      !                !
      !   (PAGE 26)    !
      +----------------+
                .
                .
      +----------------+
      !       k7       !
      !----------------!
      !     GOSUB      !
      !  Menu1_start   !
      !                !
      !   (PAGE 1)     !
      +----------------+
                v
```

```
                                        v
                                +---------------+
                                ¦      k8       ¦
                                ¦---------------¦
                                ¦     GOSUB     ¦
                                ¦  Get_status   ¦
                                ¦               ¦
                                ¦   (PAGE 36)   ¦
                                +---------------+
                                        .
                                        .
                                +---------------+
                                ¦      k9       ¦
                                ¦---------------¦
                                ¦     GOTO      ¦
                                ¦   Shutdown    ¦
                                ¦               ¦
                                ¦   (PAGE 64)   ¦
                                +-------+-------+
                                        ¦
                                +-------+-------+
                                ¦ Clear the     ¦
                                ¦ screen        ¦
                                ¦---------------¦
                                ¦Terminal Output¦
                                +-------+------/
                                        ¦
                                +---------------+
                                ¦***************¦
                                ¦     MENU2     ¦
                                ¦***************¦
                                ¦               ¦
                                ¦ Display Menu  ¦
                                ¦ #2 options &  ¦
                                ¦ current       ¦
                                ¦ conditions    ¦
                                +-------+-------+
                                        ¦
+------------------------------------->¦
¦                               +-------+-------+
¦                               ¦ Menu_flag = 2 ¦
¦                               +-------+-------+
¦                                       ¦
¦                               +-------+-------+
¦                               ¦ Display the   ¦
¦                               ¦ options for   ¦
¦                               ¦ Menu #2       ¦
¦                               ¦---------------¦
¦                               ¦Terminal Output¦
¦                               +-------+------/
¦                                       ¦
¦                                       ¦
¦                                       ¦
¦                                       ¦
¦                                       ¦
¦                                       ¦
¦                                       ¦
¦                                       ¦
                                        v
```

```
^                                         v
:                                 +-------+-------+
:                                 : Display       :
:                                 : current star  :
:                                 : values, star #:
:                                 : X position,   :
:                                 : Y position, & :
^                                 : # of acquisit-:
:                                 : ion tries     :
:                                 :---------------:
:                                 :Terminal Output:
:                                 +-------+-------/
:                                         :
:                              +----------+-----------+
:                              \STATUS 12,5;Tkr_status/
:                               \--------------------/
:                                \ (Get tracker     /
:                                 : status from   :
^                                 : the interface):
:                                 +-------+-------+
:                                         :
:                              +----------+-----------+
:                              : Tkr_command =  10 +  :
:                              : BINAND(Tkr_status,3) :
:                              +----------+-----------+
:                                         :
:                                 +-------+-------+
:                        case 10 /     SELECT      \  case 12
:               +--------------<    Tkr_command    >---------------+
:               :               \                 /                :
:               :                +-------+-------+                 :
:               :                        :case 11                  :
:       +-------+-------+        +-------+-------+         +-------+-------+
:       :     GOSUB     :        :     GOSUB     :         :     GOSUB     :
:       :   Get_data    :        :  Trans_error  :         :   Get_data    :
:       :  (PAGE 43)    :        :  (PAGE 57)    :         :  (PAGE 43)    :
:       +-------+-------+        +-------+-------+         +-------+-------+
:               :                        :                         :
:       +-------+-------+                :                         :
:       :     GOSUB     :                :                         :
:       : Trans_error   :                :                         :
:       :  (PAGE 57)    :                :                         :
:       +-------+-------+                :                         :
:               :                        v                         :
:               +------------------------>:<-----------------------+
:                                 +-------+-------+
:                                 :     GOSUB     :
:                                 :  Check_data   :
:                                 :  (PAGE 15)    :
:                                 +-------+-------+
:                                         :
+----------------<------------------------+
                      +---------------+
                      |***************|
                      |  RE_DISPLAY   |
                      |***************|
                      |               |
                      | Redisplay the|
                      | current       |
                      | screen        |
                      +-------+-------+
                              |
                      +-------+------+
              No /        IF          \
          +-----<  Menu_flag = 1       >
          |      \                    /
          |           +-------+------+
          |                   | Yes
          |           +-------+-------+
          |           |     GOSUB     |
          |           |  Menu1_start  |
          |           |   (PAGE 1)    |
          |           +---------------+
          |
          +------------->|
                      +-------+------+
              No /        IF          \
          +-----<  Menu_flag = 2       >
          |      \                    /
          |           +-------+------+
          |                   |Yes
          |           +-------+-------+
          |           |     GOSUB     |
          |           |  Menu2_start  |
          |           |   (PAGE 5)    |
          |           +---------------+
          |
          +------------->|
                      +-------+-------+
                      |     RETURN    |
                      +---------------+

                      +---------------+
                      |***************|
                      |Check_flgs_men1|
                      |***************|
                      |               |
                      | Check and then|
                      | display all   |
                      | flags for     |
                      | Menu #1       |
                      +-------+-------+
                              |
                      +-------+-------+
                      |     GOSUB     |
                      | Chk_self_tst  |
                      |   (PAGE 11)   |
                      +-------+-------+
                              |
                              |
                              |
                              v
```

```
             v
    +--------+--------+
    !      GOSUB      !
    !   Check_stars   !
    !   (PAGE 11)     !
    +--------+--------+
             !
    +--------+--------+
    !      GOSUB      !
    !   Check_adapt   !
    !   (PAGE 14)     !
    +--------+--------+
             !
    +--------+--------+
    !      GOSUB      !
    !   Check_acqu    !
    !   (PAGE 16)     !
    +--------+--------+
             !
    +--------+--------+
    !      GOSUB      !
    !   Check_data    !
    !   (PAGE 15)     !
    +--------+--------+
             !
    +--------+--------+
    !      RETURN     !
    +-----------------+
                +----------------+
                |****************|
                | CHK_SELF_TST   |
                |****************|
                |                |
                | Check and      |
                | display the    |
                | self test      |
                | status         |
                +-------+--------+
                        |
                +-------+--------+
                | Position the   |
                | cursor at loc  |
                | of self test   |
                | flag           |
                |----------------|
                |Terminal Output |
                +-------+-------/
                        |
                +-------+-------+
         case 0/     SELECT     \ case 1
        +-----<  Self_test_flag  >------+
        |      \                /       |
        |       +---------------+       |
        |                               |
+-------+-------+               +-------+-------+
|   Disp_flag$  |               |   Disp_flag$  |
|       =       |               |       =       |
|    Off_flag$  |               |    On_flag$   |
+-------+-------+               +-------+-------+
        |                               |
        +-------------->|<--------------+
                        |
                +-------+--------+
                |     Print      |
                |   Disp_flag$   |
                |----------------|
                |Terminal Output |
                +-------+-------/
                        |
                +----------------+
                |     RETURN     |
                +----------------+


                +----------------+
                |****************|
                |  CHECK_STARS   |
                |****************|
                |                |
                | Check and      |
                | display the    |
                | individual     |
                | star status    |
                +-------+--------+
                        |
                        |
                        |
                        v
                        v
                +-------+-------+
                ¦ Position the  ¦
                ¦ cursor at loc ¦
                ¦ of star #1    ¦
                ¦ disabled      ¦
                ¦---------------¦
                ¦Terminal Output¦
                +-------+------/
                        ¦
                +-------+------+
         case 0/    SELECT     \ case 1
        +-----<    Star1_flag   >------+
        ¦      \               /       ¦
        ¦       +-------------+        ¦
        ¦                              ¦
+-------+-------+              +-------+-------+
¦  Print "1"    ¦              ¦   Print " "   ¦
¦               ¦              ¦               ¦
¦---------------¦              ¦---------------¦
¦Terminal Output¦              ¦Terminal Output¦
+-------+------/               +-------+------/
        ¦                              ¦
+-------+-------+              +-------+-------+
¦ Position the  ¦              ¦ Position the  ¦
¦ cursor at loc ¦              ¦ cursor at loc ¦
¦ of star #1    ¦              ¦ of star #1    ¦
¦ enabled       ¦              ¦ enabled       ¦
¦ Print " "     ¦              ¦ Print "1"     ¦
¦---------------¦              ¦---------------¦
¦Terminal Output¦              ¦Terminal Output¦
+-------+------/               +-------+------/
        ¦                              ¦
        +-------------->¦<-------------+
                        ¦
                +-------+-------+
                ¦ Position the  ¦
                ¦ cursor at loc ¦
                ¦ of star #2    ¦
                ¦ disabled      ¦
                ¦---------------¦
                ¦Terminal Output¦
                +-------+------/
                        ¦
                +-------+------+
         case 0/    SELECT     \ case 1
        +-----<    Star2_flag   >------+
        ¦      \               /       ¦
        ¦       +-------------+        ¦
        ¦                              ¦
+-------+-------+              +-------+-------+
¦  Print "2"    ¦              ¦   Print " "   ¦
¦               ¦              ¦               ¦
¦---------------¦              ¦---------------¦
¦Terminal Output¦              ¦Terminal Output¦
+-------+------/               +-------+------/
        ¦                              ¦
        ¦                              ¦
        ¦                              ¦
        v                              v
        v                                v
+-------+-------+                +-------+-------+
¦ Position the  ¦                ¦ Position the  ¦
¦ cursor at loc ¦                ¦ cursor at loc ¦
¦ of star #2    ¦                ¦ of star #2    ¦
¦ enabled       ¦                ¦ enabled       ¦
¦ Print " "     ¦                ¦ Print "2"     ¦
¦---------------¦                ¦---------------¦
¦Terminal Output¦                ¦Terminal Output¦
+-------+------/                 +-------+------/
        ¦                                ¦
        +-------------->¦<---------------+
                        ¦
                +-------+-------+
                ¦ Posi:ion the  ¦
                ¦ cursor at loc ¦
                ¦ of star #3    ¦
                ¦ disabled      ¦
                ¦---------------¦
                ¦Terminal Output¦
                +-------+------/
                        ¦
                +-------+-------+
          case 0/    SELECT     \ case 1
        +-----<    Star3_flag    >-------+
        ¦      \                /        ¦
        ¦       +---------------+        ¦
        ¦                                ¦
+-------+-------+                +-------+-------+
¦  Print "3"    ¦                ¦   Print " "   ¦
¦               ¦                ¦               ¦
¦---------------¦                ¦---------------¦
¦Terminal Output¦                ¦Terminal Output¦
+-------+------/                 +-------+------/
        ¦                                ¦
+-------+-------+                +-------+-------+
¦ Position the  ¦                ¦ Position the  ¦
¦ cursor at loc ¦                ¦ cursor at loc ¦
¦ of star #3    ¦                ¦ of star #3    ¦
¦ enabled       ¦                ¦ enabled       ¦
¦ Print " "     ¦                ¦ Print "3"     ¦
¦---------------¦                ¦---------------¦
¦Terminal Output¦                ¦Terminal Output¦
+-------+------/                 +-------+------/
        ¦                                ¦
        +-------------->¦<---------------+
                        ¦
                +-------+-------+
                ¦    RETURN     ¦
                +---------------+
               +---------------+
               |***************|
               |  CHECK_ADAPT  |
               |***************|
               |               |
               | Check and     |
               | display the   |
               | adaptive rate |
               | status        |
               +-------+-------+
                       |
               +-------+-------+
               | Position the  |
               | cursor at loc |
               | of adaptive   |
               | rate flag     |
               |---------------|
               |Terminal Output|
               +-------+------/
                       |
               +-------+------+
         case 0/    SELECT     \ case 1
        +-----<   Adapt_rate    >------+
        |      \               /       |
        |      +--------------+        |
        |                              |
        |                              |
+-------+-------+              +-------+-------+
|   Disp_flag$  |              |   Disp_flag$  |
|       =       |              |       =       |
|    Off_flag$  |              |    On_flag$   |
+-------+-------+              +-------+-------+
        |                              |
        +------------->|<--------------+
                       |
               +-------+-------+
               |     Print     |
               |   Disp_flag$  |
               |---------------|
               |Terminal Output|
               +-------+------/
                       |
               +---------------+
               |     RETURN    |
               +---------------+
                 +---------------+
                 |***************|
                 |  CHECK_DATA   |
                 |***************|
                 |               |
                 | Check and     |
                 | display the   |
                 | status of the |
                 | data taking   |
                 | flag          |
                 +-------+-------+
                         |
                 +-------+-------+
                 | Position the  |
                 | cursor at loc |
                 | of take data  |
                 | flag          |
                 |---------------|
                 |Terminal Output|
                 +-------+------/
                         |
                 +-------+------+
         case 0/     SELECT     \ case 1
        +-----<  Tak_data_flag   >------+
        |        \              /       |
        |        +--------------+       |
        |                               |
+-------+--------+              +-------+--------+
|   Disp_flag$   |              |   Disp_flag$   |
|       =        |              |       =        |
|    Off_flag$   |              |    On_flag$    |
+-------+--------+              +-------+--------+
        |                               |
+-------+--------+              +-------+--------+
|     Print      |              |     Print      |
| Disp_flag$,    |              |   Disp_flag$   |
| "            " |              |                |
|----------------|              |----------------|
|Terminal Output |              |Terminal Output |
+-------+-------/               +-------+-------/
        |                               |
        +-------------->|<--------------+
                        |
                 +---------------+
                 |    RETURN     |
                 +---------------+
                        +---------------+
                        |***************|
                        |   CHECK_ACQU  |
                        |***************|
                        |               |
                        | Check and     |
                        | display the   |
                        | status of the |
                        | acquisition   |
                        | flag          |
                        +-------+-------+
                                |
                        +-------+-------+
                        | Position the  |
                        | cursor at the |
                        | location of   |
                        | the acquisit- |
                        | ion flag      |
                        |---------------|
                        |Terminal Output|
                        +-------+------/
                                |
                        +-------+-------+
              case 0/      SELECT        \case 1
              +-----<    Acqu_flag        >------+
              |      \                   /       |
              |     +-------------------+        |
              |                                  |
    +---------+--------+              +---------+--------+
    |   Disp_flag$     |              |   Disp_flag$     |
    |       =          |              |       =          |
    |    "MANUAL"      |              |     "AUTO"       |
    +---------+--------+              +---------+--------+
              |                                 |
    +---------+-------+               +---------+--------+
   /         IF        \No            |   Disp_flag2$    |
  <   Acqu_type = 0     >------+      |       =          |
   \                   /       |      |"                "|
    +---------+-------+        |      +---------+--------+
              |Yes             |                |
    +---------+--------+       |                |
    |   Disp_flag2$    |       |                |
    |       =          |       |                |
    |     "OFF"        |       |                |
    +---------+--------+       |                v
              |                |                |
              |<---------------+                |
    +---------+-------+                         |
   /         IF        \No                      |
  <   Acqu_type = 1     >------+                v
   \                   /       |                |
    +---------+-------+        |                |
              |Yes             |                |
    +---------+--------+       |                |
    |   Disp_flag2$    |       |                v
    |       =          |       |                |
    |   "FULL FOV"     |       |                |
    +---------+--------+       |                |
              |                |                |
              v                v                v
```

```
          v               v               v
          |<--------------+               |
  +-------+------+                        |
 /      IF        \No                     |
<  Acqu_type = 2   >------+               |
 \                /       |               |
  +-------+------+        |               v
          |Yes            |               |
  +-------+-------+       |               |
  |  Disp_flag2$  |       |               |
  |       =       |       |               |
  |  "FULL EDGE"  |       |               v
  +-------+-------+       |               |
          |               |               |
          |<--------------+               |
  +-------+------+                        |
 /      IF        \No                     v
<  Acqu_type = 3   >------+               |
 \                /       |               |
  +-------+------+        |               |
          |Yes            |               |
  +-------+-------+       |               v
  |  Disp_flag2$  |       |               |
  |       =       |       |               |
  |  "VEC EDGE"   |       |               |
  +-------+-------+       |               |
          |               |               |
          |               v               |
          +-------------->|<--------------+
                  +-------+-------+
                  | Display       |
                  | Disp_flag$,   |
                  | Disp_flag2$   |
                  |---------------|
                  |Terminal Output|
                  +-------+------/
                          |
                  +-------+-------+
                  |     RETURN    |
                  +---------------+


                  +---------------+
                  |***************|
                  |   SELF_TEST   |
                  |***************|
                  |               |
                  | Toggle the    |
                  | self test flag|
                  | and set up the|
                  | variables to  |
                  | be sent to the|
                  | interface box |
                  +-------+-------+
                          |
               +----------+----------+
               ( DISABLE interrupts  )
               ( from soft keys      )
               +----------+----------+
                          v
```

```
                    ¦
                    ¦
            +-------+--------+
            ¦ Self_test_flag ¦
            ¦      =  1 -    ¦
            ¦ Self_test_flag ¦
            +-------+--------+
                    ¦
            +-------+--------+
            ¦     GOSUB      ¦
            ¦ Chk_self_tst   ¦
            ¦   (PAGE 11)    ¦
            +-------+--------+
                    ¦
            +-------+--------+
            ¦Inter_face= 224 ¦
            +-------+--------+
                    ¦
            +-------+--------+
            ¦   Send_msg$    ¦
            ¦       =        ¦
            ¦"Self Test Cmd" ¦
            +-------+--------+
                    ¦
            +-------+--------+
            ¦     GOSUB      ¦
            ¦ Cmd_interface  ¦
            ¦   (PAGE 38)    ¦
            +-------+--------+
                    ¦
       +------------+-----------+
       ( ENABLE interrupts      )
       ( from soft keys         )
       +------------+-----------+
                    ¦
            +-------+--------+
            ¦     RETURN     ¦
            +----------------+


            +----------------+
            ¦****************¦
            ¦  STAR_DISABLE  ¦
            ¦****************¦
            ¦                ¦
            ¦ Disable the    ¦
            ¦ current star   ¦
            ¦ and change the ¦
            ¦ star flag to   ¦
            ¦ show such      ¦
            ¦ status         ¦
            +-------+--------+
                    ¦
     +--------------+-----------+
     ( DISABLE interrupts       )
     ( from soft keys           )
     +--------------+-----------+
                    ¦
                    v
```

```
                            v
                   +--------+-------+
          No  /          IF          \
      +------<    Curr_star = 1       >
      :       \                      /
      :            +--------+-------+
      :                     : Yes
      :            +--------+--------+
      :            :Star1_flag = 0 :
      :            +--------+--------+
      :                     :
      +------------------->:
                   +--------+-------+
          No  /          IF          \
      +------<    Curr_star = 2       >
      :       \                      /
      :            +--------+-------+
      :                     : Yes
      :            +--------+--------+
      :            :Star2_flag = 0 :
      :            +--------+--------+
      :                     :
      +------------------->:
                   +--------+-------+
          No  /          IF          \
      +------<    Curr_star = 3       >
      :       \                      /
      :            +--------+-------+
      :                     : Yes
      :            +--------+--------+
      :            :Star3_flag = 0 :
      :            +--------+--------+
      :                     :
      +------------------->:
                   +--------+--------+
                   :      GOSUB      :
                   :   Check_stars   :
                   :    (PAGE 11)    :
                   +--------+--------+
                            :
                   +--------+--------+
                   :Inter_face= 52 :
                   +--------+--------+
                            :
                   +--------+--------+
                   :    Send_msg$    :
                   :        =        :
                   :"Star Disable " :
                   +--------+--------+
                            :
                   +--------+--------+
                   :      GOSUB      :
                   : Cmd_interface   :
                   :    (PAGE 38)    :
                   +--------+--------+
                            :
                            :
                            :
                            v
```

```
                          v
               +---------+--------+
               |Inter_face =      |
               |Ctble(Curr_star)  |
               +---------+--------+
                         |
               +---------+--------+
               |    Send_msg$     |
               |        =         |
               |    "Star #"      |
               +---------+--------+
                         |
               +---------+--------+
               |      GOSUB       |
               | Cmd_interface    |
               |   (PAGE 38)      |
               +---------+--------+
                         |
          +--------------+-------------+
          ( ENABLE interrupts          )
          (  from soft keys            )
          +--------------+-------------+
                         |
               +---------+--------+
               |      RETURN      |
               +------------------+


               +------------------+
               |***************** |
               |   STAR_ENABLE    |
               |***************** |
               |                  |
               | Enable  the      |
               | current star     |
               | and change the   |
               | star flag to     |
               | show such        |
               | status           |
               +---------+--------+
                         |
          +--------------+-------------+
          ( DISABLE interrupts         )
          (  from soft keys            )
          +--------------+-------------+
                         |
               +---------+--------+
         No  /          IF          \
      +-----<   Curr_star = 1        >
      |      \                      /
      |        +---------+--------+
      |                  | Yes
      |        +---------+--------+
      |        |Star1_flag = 1    |
      |        +---------+--------+
      |                  |
      |                  |
      |                  |
      v                  v
```

```
v               v
|               |
+-------------->|
        +-------+------+
    No /       IF       \
+-----<  Curr_star = 2   >
|      \                /
|       +-------+-------+
|               | Yes
|       +-------+--------+
|       |Star2_flag = 1  |
|       +-------+--------+
|               |
+-------------->|
        +-------+------+
    No /       IF       \
+-----<  Curr_star = 3   >
|      \                /
|       +-------+-------+
|               | Yes
|       +-------+--------+
|       |Star3_flag = 1  |
|       +-------+--------+
|               |
+-------------->|
        +-------+--------+
        |     GOSUB      |
        |  Check_stars   |
        |   (PAGE 11)    |
        +-------+--------+
                |
        +-------+--------+
        |Inter_face= 120|
        +-------+--------+
                |
        +-------+--------+
        |   Send_msg$    |
        |       =        |
        |"Star Enable  "|
        +-------+--------+
                |
        +-------+--------+
        |     GOSUB      |
        | Cmd_interface  |
        |   (PAGE 38)    |
        +-------+--------+
                |
        +-------+---------+
        |Inter_face =     |
        |Ctble(Curr_star)|
        +-------+---------+
                |
        +-------+--------+
        |   Send_msg$    |
        |       =        |
        |   "Star #"     |
        +-------+--------+
                |
                |
                v
```

```
                   v
          +--------+--------+
          ¦      GOSUB      ¦
          ¦ Cmd_interface   ¦
          ¦    (PAGE 38)    ¦
          +--------+--------+
                   ¦
     +-------------+-----------+
     ( ENABLE interrupts       )
     ( from soft keys          )
     +-------------+-----------+
                   ¦
          +--------+--------+
          ¦      RETURN     ¦
          +-----------------+
          +---------------+
          |***************|
          |   ADAPT_RATE  |
          |***************|
          |               |
          |Toggle the ada-|
          |ptive rate flag|
          |and set up the |
          |variables to   |
          |be sent to the |
          |interface box  |
          +-------+-------+
                  |
      +-----------+-----------+
      ( DISABLE interrupts    )
      (  from soft keys       )
      +-----------+-----------+
                  |
          +-------+-------+
          |Adapt_rate_flag|
          |       =  1 -  |
          |Adapt_rate_flag|
          +-------+-------+
                  |
          +-------+-------+
          |     GOSUB     |
          |  Check_adapt  |
          |   (PAGE 14)   |
          +-------+-------+
                  |
          +-------+-------+
          |Inter_face= 180|
          +-------+-------+
                  |
          +-------+-------+
          |   Send_msg$   |
          |       =       |
          |"Adaptive Rate"|
          +-------+-------+
                  |
          +-------+-------+
          |     GOSUB     |
          | Cmd_interface |
          |   (PAGE 38)   |
          +-------+-------+
                  |
      +-----------+-----------+
      ( ENABLE interrupts     )
      (  from soft keys       )
      +-----------+-----------+
                  |
          +-------+-------+
          |     RETURN    |
          +---------------+
        +---------------+
        |***************|
        |  ACQUISITION  |
        |***************|
        |               |
        |Toggle the acq-|
        |uisition  flag |
        |and set up the |
        |variables to   |
        |be sent to the |
        |interface box  |
        +-------+-------+
                |
     +----------+----------+
     ( DISABLE interrupts  )
     ( from soft keys      )
     +----------+----------+
                |
        +-------+-------+
        |   Acqu_flag   |
        |       =       |
        | 1 - Acqu_flag |
        +-------+-------+
                |
        +-------+-------+
        |     GOSUB     |
        |   Check_acqu  |
        |   (PAGE 16)   |
        +-------+-------+
                |
        +-------+------+
       /       IF       \ No
      <  Acqu_flag = 0   >------+
       \                /       |
        +-------+------+        |
                |Yes            |
        +-------+-------+       |
        | Beep the      |       |
        | terminal bell |       v
        |---------------|       |
        |Terminal Output|       |
        +-------+------/        |
                |               |
+--------------->|              v
|        /------+-------+       |
|       |  User Input   |       |
^       |---------------|       |
|       | "Please input |       |
|       | Acqusition    |       v
|       | type 0-off,   |       |
|       | 1-FULL FOV,   |       |
|       | 2-FULL EDGE,  |       |
|       | 3-VEC EDGE >" |       |
|       |               |       |
|       | Read Acqu_type|       |
|       +-------+-------+       |
|               |               |
|               |               |
|               |               |
^               v               v
^               v               v
|               |               |
|       +-------+-------+       |
|      /       IF        \ Yes  |
|     <-1 < Acqu_type < 4>----->|
|      \                 /      |
|       +-------+-------+       |
^               | No            |
|       +-------+--------+      |
|       | Beep the       |      v
|       | terminal bell  |      |
|       |----------------|      |
^       |Terminal Output |      |
|       +-------+-------/       |
|               |               v
|       +-------+--------+      |
|       | Display        |      |
^       | "INVALID type  |      |
|       |  press <CONT>  |      |
|       |  to try again" |      |
|       |----------------|      |
|       |Terminal Output |      v
|       +-------+-------/       |
|               |               |
+---------------+               |
                                |
                |<--------------+
        +-------+--------+
        |****************|
        |   SEND_ACQU    |
        |****************|
        +-------+--------+
                |
        +-------+--------+
        |Inter_face= 204 |
        +-------+--------+
                |
        +-------+--------+
        |   Send_msg$    |
        |       =        |
        |"Acquisition  " |
        +-------+--------+
                |
        +-------+--------+
        |     GOSUB      |
        | Cmd_interface  |
        |   (PAGE 38)    |
        +-------+--------+
                |
    +-----------+-----------+
    ( ENABLE interrupts     )
    (  from soft keys       )
    +-----------+-----------+
                |
        +-------+--------+
        |     RETURN     |
        +----------------+
    +--------+-------+
    |****************|
    |   TAKE_DATA    |
    |****************|
    |                |
    | Toggle the     |
    | take data      |
    | flag, and set  |
    | up variables   |
    | associated     |
    | with the curr- |
    | ent status     |
    +--------+-------+
             |
+------------+----------+
( DISABLE interrupts    )
( from soft keys        )
+------------+----------+
             |
    +--------+-------+
    | Tak_data_flag  |
    |       =        |
    |1-Tak_data_flag |
    +--------+-------+
             |
    +--------+-------+
    |     GOSUB      |
    |   Check_data   |
    |   (PAGE 15)    |
    +--------+-------+
             |
    +--------+------+
   /       IF       \ Yes
  <Tak_data_flag = 0 >-------+
   \                /        |
    +--------+------+        |
             | No            |
    +--------+-------+       |
    |Data_count = 0  |       |
    +--------+-------+       |
             |               v
    +--------+--------+      |
    | Max_num_files   |      |
    |        =        |      |
    |Nfiles+Max_files |      |
    +--------+--------+      |
             |               |
    +--------+------+        |
   /       IF       \ No     v
  < Nfiles<=Max_files>------>|
   \                /        |
    +--------+------+        |
             | Yes           |
    +--------+-------+       |
    |  Printer is 1  |       |
    +--------+-------+       v
             |               |
             |               |
             |               |
             v               v
```

```
                   v                  v
         +---------+--------+         |
        /          IF        \ No     |
       <    Nfiles = 0        >------>|
        \                    /        |
         +---------+--------+         |
                   | Yes              |
         +---------+---------+        |
         | Beep the          |        |
         | terminal bell     |        v
         |-------------------|        |
         |Terminal Output    |        |
         +---------+--------/         |
                   |                  |
         +---------+---------+        |
         | Clear the         |        |
         | display line      |        |
         |-------------------|        |
         |Terminal Output    |        v
         +---------+--------/         |
                   |                  |
+----------------->|                  |
|       /----------+---------+        |
|       | User Input         |        |
|       |--------------------|        |
|       |"Please input       |        v
|       | initial data       |        |
|       | file # > "         |        |
|       |                    |        |
^       | read Nfiles        |        |
|       +----------+---------+        |
|                  |                  |
|       +----------+--------+         |
|      /           IF        \Yes     v
|     <   0 < Nfiles < 99     >------>|
|      \                     /        |
|       +----------+--------+         |
|                  | No               |
|       +----------+---------+        |
^       | Beep the           |        |
|       | terminal bell      |        |
|       |--------------------|        v
|       |Terminal Output     |        |
|       +----------+--------/         |
|                  |                  |
|       +----------+---------+        |
|       | Display            |        |
|       | "INVALID file      |        |
|       | #, try again!"     |        |
^       |--------------------|        v
|       |Terminal Output     |        |
|       +----------+--------/         |
|                  |                  |
|                  |                  |
|                  |                  |
|                  |                  |
|                  |                  |
|                  |                  |
|                  |                  |
^                  v                  v
^                 v                 v
¦        +--------+--------+        ¦
¦        ¦ PAUSE           ¦        ¦
¦        ¦ Clear display   ¦        v
¦        ¦ line            ¦        ¦
¦        ¦-----------------¦        ¦
¦        ¦Terminal Output  ¦        ¦
¦        +--------+-------/         ¦
¦                 ¦                 ¦
+-----------------+                 ¦
                                    ¦
                  ¦<----------------+
         +--------+--------+
         ¦*****************¦
         ¦  TAKE_DATA_END  ¦
         ¦*****************¦
         +--------+--------+
                  ¦
         +--------+-------+
        /        IF        \ No
       < Data_count > 0     >-------+
        \                  /        ¦
         +--------+-------+         ¦
                  ¦ Yes             ¦
         +--------+--------+        v
         ¦      GOSUB      ¦        ¦
         ¦   Write_data    ¦        ¦
         ¦    (PAGE 52)    ¦        ¦
         +--------+--------+        ¦
                  ¦                 ¦
                  ¦<----------------+
    +-------------+-----------+
    ( DISABLE interrupts      )
    ( from soft keys          )
    +-------------+-----------+
                  ¦
         +--------+--------+
         ¦      RETURN     ¦
         +-----------------+


         +-----------------+
         ¦*****************¦
         ¦    TRACK_IT     ¦
         ¦*****************¦
         ¦ Set up vars     ¦
         ¦ used for the    ¦
         ¦ commanded to    ¦
         ¦ track position  ¦
         +--------+--------+
                  ¦
    +-------------+-----------+
    ( DISABLE interrupts      )
    ( from soft keys          )
    +-------------+-----------+
                  ¦
         +--------+--------+
         ¦Inter_face= 84   ¦
         +--------+--------+
                  v
```

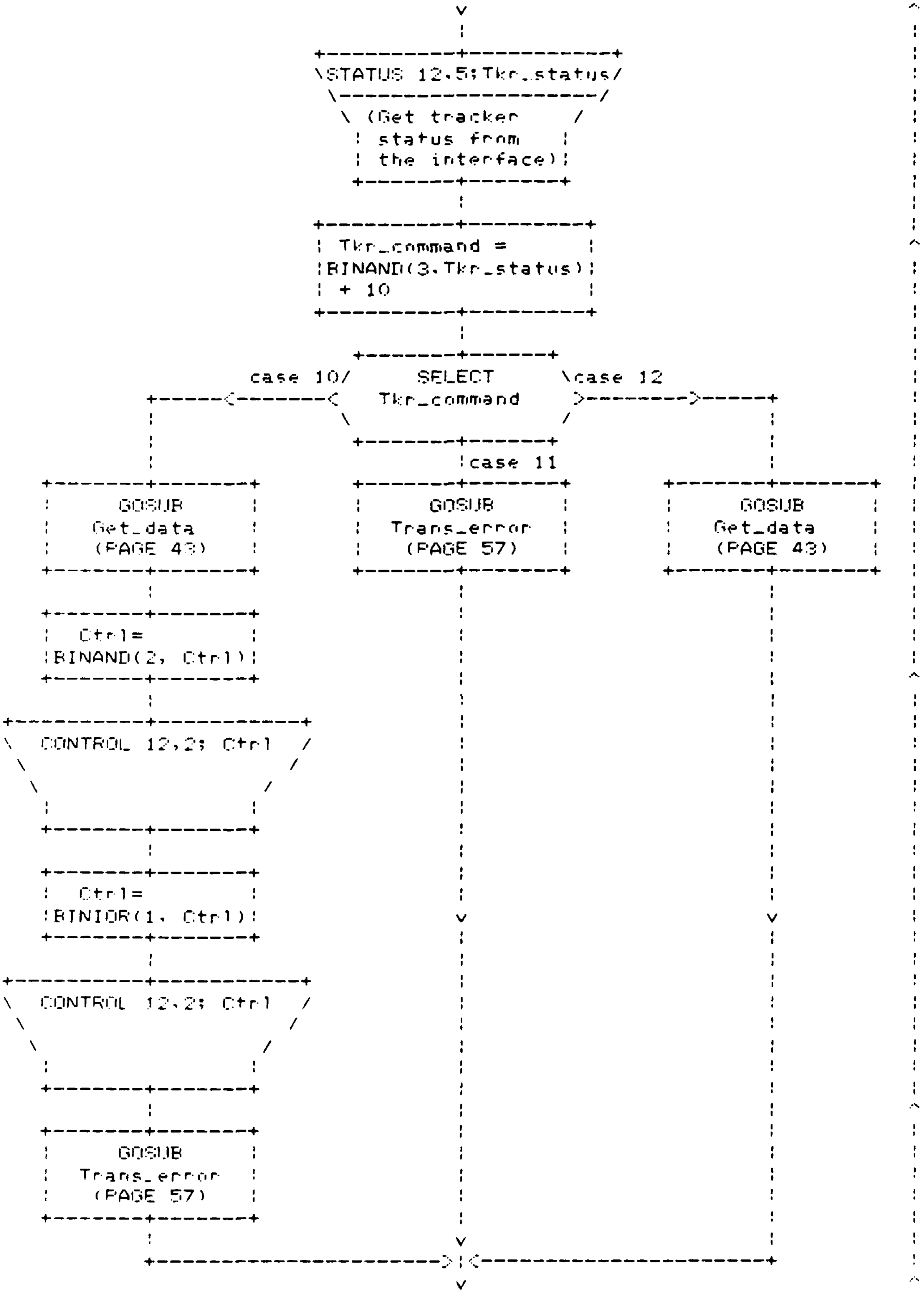
```
          v
          :
 +--------+--------+
 :    Send_msg$    :
 :        =        :
 :"Track @ X,Y    ":
 +--------+--------+
          :
 +--------+--------+
 :      GOSUB      :
 :  Cmd_interface  :
 :    (PAGE 38)    :
 +--------+--------+
          :
 +--------+---------+
 :Inter_face =      :
 :Ctble(Curr_star)  :
 +--------+---------+
          :
 +--------+--------+
 :    Send_msg$    :
 :        =        :
 :     "Star #"    :
 +--------+--------+
          :
 +--------+--------+
 :      GOSUB      :
 :  Cmd_interface  :
 :    (PAGE 38)    :
 +--------+--------+
          :
+---------+---------+
:Inter_face=X_posn  :
+---------+---------+
          :
 +--------+--------+
 :    Send_msg$    :
 :        =        :
 :  "X Position"   :
 +--------+--------+
          :
 +--------+--------+
 :      GOSUB      :
 :  Cmd_interface  :
 :    (PAGE 38)    :
 +--------+--------+
          :
 +--------+--------+
 :      GOSUB      :
 :  Cmd_interface  :
 :    (PAGE 38)    :
 +--------+--------+
          :
+---------+---------+
:Inter_face=Y_posn  :
+---------+---------+
          :
          :
          :
          v
```

```
                v
        +-------+-------+
        !   Send_msg$   !
        !       =       !
        ! "Y Position"  !
        +-------+-------+
                !
        +-------+-------+
        !     GOSUB     !
        ! Cmd_interface !
        !   (PAGE 38)   !
        +-------+-------+
                !
        +-------+-------+
        !     GOSUB     !
        ! Cmd_interface !
        !   (PAGE 38)   !
        +-------+-------+
                !
    +-----------+---------+
    ( ENABLE interrupts   )
    ( from soft keys      )
    +-----------+---------+
                !
        +-------+-------+
        !    RETURN     !
        +---------------+


        +---------------+
        !***************!
        !   SET_STAR    !
        !***************!
        !               !
        ! Query user for!
        ! new current   !
        ! star          !
        +-------+-------+
                !
        +-------+-------+
        ! Clear the     !
        ! display line  !
        ! Beep terminal !
        !---------------!
        !Terminal Output!
        +-------+------/
                !
+-------------->!
!        /------+-------+
!       ! User  Input   !
!       !---------------!
!       ! "Please input !
!       !  NEW star # >"!
!       !               !
!       ! read Curr_star!
!       +-------+-------+
!               !
!               !
!               !
^               v
^                v
¦         +-------+-------+
¦        /       IF        \ Yes
¦       < 0 < Curr_star < 4>-------+
¦        \                 /       ¦
¦         +-------+-------+        ¦
¦                 ¦ No             ¦
¦         +-------+--------+       ¦
¦         ¦ Beep the       ¦       ¦
¦         ¦ terminal bell  ¦       ¦
¦         ¦----------------¦       ¦
¦         ¦Terminal Output ¦       ¦
¦         +-------+-------/        ¦
^                 ¦                v
¦         +-------+--------+       ¦
¦         ¦ Display        ¦       ¦
¦         ¦ "INVALID star  ¦       ¦
¦         ¦  number, try   ¦       ¦
¦         ¦  again!"       ¦       ¦
¦         ¦----------------¦       ¦
¦         ¦Terminal Output ¦       ¦
¦         +-------+-------/        ¦
¦                 ¦                ¦
+-----------------+                ¦
                                   v
                  ¦<---------------+
          +-------+--------+
          ¦****************¦
          ¦ END_SET_STAR   ¦
          ¦**************  ¦
          +-------+--------+
                  ¦
          +-------+--------+
          ¦     RETURN     ¦
          +----------------+


          +----------------+
          ¦****************¦
          ¦ DROP_CRITERIA  ¦
          ¦****************¦
          ¦                ¦
          ¦ Query the user ¦
          ¦ for the NEW    ¦
          ¦ drop criteria  ¦
          +-------+--------+
                  ¦
     +------------+------------+
     ( DISABLE interrupts      )
     ( from soft keys          )
     +------------+------------+
                  ¦
          +-------+--------+
          ¦ Clear the      ¦
          ¦ display line   ¦
          ¦----------------¦
          ¦Terminal Output ¦
          +-------+-------/
                  ¦
                  v
```

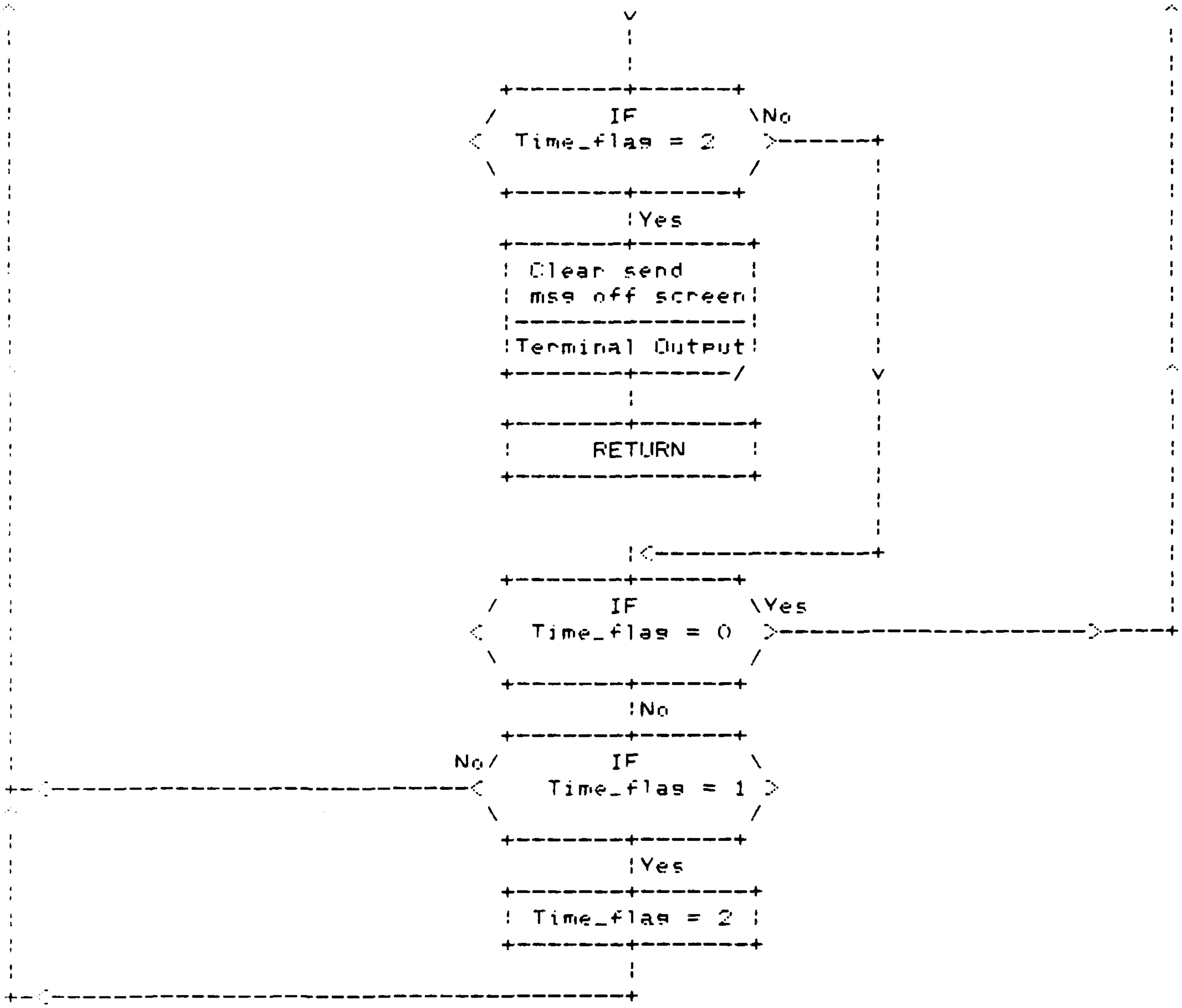
```
                 v
        +--------+--------+
        | Beep the        |
        | terminal bell   |
        |-----------------|
        |Terminal Output  |
        +--------+-------/
                 |
+---------------->|
|        /-------+--------+
|       |   User Input    |
|       |-----------------|
|       | "Please input   |
|       |  the NEW drop   |
|       |  criteria >"    |
|       |                 |
|       | read Num_times  |
|       +--------+--------+
|                |
^       +--------+-------+
|      /        IF        \ Yes
|     <0< Num_times <=15  >--------+
|      \                  /        |
|       +--------+-------+         |
|                |No               |
|       +--------+--------+        |
|       | Beep the        |        |
|       | terminal bell   |        |
|       |-----------------|        |
^       |Terminal Output  |        v
|       +--------+-------/         |
|                |                 |
|       +--------+--------+        |
|       | Display         |        |
|       | "INVALID #,     |        |
|       | please try      |        |
|       | again!"         |        |
|       |-----------------|        |
|       |Terminal Output  |        |
|       +--------+-------/         |
|                |                 |
+----------------+                 |
                                   |
                 |<----------------+
        +--------+--------+
        |**************** |
        | END_CRITERIA    |
        |**************** |
        +--------+--------+
                 |
        +--------+--------+
        |Inter_face= 44   |
        +--------+--------+
                 |
        +--------+--------+
        |    Send_msg$    |
        |        =        |
        |"Drop Criteria"  |
        +--------+--------+
                 v
                 v
                 |
        +--------+--------+
        |      GOSUB      |
        | Cmd_interface   |
        |    (PAGE 38)    |
        +--------+--------+
                 |
        +--------+---------+
        |Inter_face =      |
        |Ctble(Num_times)  |
        +--------+---------+
                 |
        +--------+--------+
        |    Send_msg$    |
        |        =        |
        |   "Drop data"   |
        +--------+--------+
                 |
        +--------+--------+
        |      GOSUB      |
        | Cmd_interface   |
        |    (PAGE 38)    |
        +--------+--------+
                 |
    +------------+-----------+
    ( ENABLE interrupts      )
    (  from soft keys        )
    +------------+-----------+
                 |
        +--------+--------+
        |     RETURN      |
        +-----------------+
        +---------------+
        |***************|
        |     SET_X     |
        |***************|
        | Query user for|
        | NEW X position|
        +-------+-------+
                |
        +-------+-------+
        | Clear the     |
        | display line  |
        | Beep terminal |
        |---------------|
        |Terminal Output|
        +-------+------/
+-------------->|
|        /------+-------+
|       | User  Input   |
^       |---------------|
|       | "Please input |
|       |  NEW X        |
|       |  position > " |
|       |               |
|       | read X_posn   |
|       +-------+-------+
|               |
|       +-------+------+
|      /       IF      \ Yes
^     <-1 < X_posn < 257 >------+
|      \               /        |
|       +-------+------+        |
|               | No            |
|       +-------+-------+       |
|       | Beep the      |       |
|       | terminal bell |       |
|       |---------------|       |
|       |Terminal Output|       |
|       +-------+------/        |
^               |               v
|       +-------+-------+       |
|       | Display       |       |
|       | "INVALID  X   |       |
|       |  position, try|       |
|       |  again!"      |       |
|       |---------------|       |
|       |Terminal Output|       |
|       +-------+------/        |
|               |               |
+---------------+               |
                                |
                |<--------------+
        +-------+-------+
        |***************|
        |   END_SET_X   |
        |************** |
        +-------+-------+
                |
        +-------+-------+
        |     RETURN    |
        +---------------+
          +---------------+
          |***************|
          |     SET_Y     |
          |***************|
          | Query user for|
          | NEW Y position|
          +-------+-------+
                  |
          +-------+-------+
          | Clear the     |
          | display line  |
          | Beep terminal |
          |---------------|
          |Terminal Output|
          +-------+-------/
+---------------->|
|          /------+--------+
|          | User  Input   |
^          |---------------|
|          | "Please input |
|          |  NEW Y        |
|          |  position > " |
|          |               |
|          | read Y_posn   |
|          +-------+-------+
|                  |
|          +-------+------+
|         /        IF      \ Yes
^        <-1 < Y_posn < 257 >--------+
|         \                /         |
|          +-------+------+          |
|                  | No              |
|          +-------+-------+         |
|          | Beep the      |         |
|          | terminal bell |         |
|          |---------------|         |
|          |Terminal Output|         |
|          +-------+-------/         |
^                  |                 v
|          +-------+-------+         |
|          | Display       |         |
|          | "INVALID  Y   |         |
|          |  position, try|         |
|          |  again!"      |         |
|          |---------------|         |
|          |Terminal Output|         |
|          +-------+-------/         |
|                  |                 |
+------------------+                 |
                                     |
                  |<-----------------+
          +-------+-------+
          |***************|
          |   END_SET_Y   |
          |***************|
          +-------+-------+
                  |
          +-------+-------+
          |    RETURN     |
          +---------------+
    +---------------+
    |***************|
    |  GET_STATUS   |
    |***************|
    | Output set    |
    | status cmd and|
    | then set flags|
    | by rec. status|
    +-------+-------+
            ¦
+-----------+----------+
( DISABLE interrupts   )
( from soft keys       )
+-----------+----------+
            ¦
    +-------+-------+
    ¦Inter_face= 210¦
    +-------+-------+
            ¦
    +-------+-------+
    ¦   Send_msg$   ¦
    ¦       =       ¦
    ¦ "Get Status"  ¦
    +-------+-------+
            ¦
    +-------+-------+
    ¦     GOSUB     ¦
    ¦ Cmd_interface ¦
    ¦   (PAGE 38)   ¦
    +-------+-------+
            ¦
    +-------+------+
   /       IF       \ No
  <   Test_flag = 0  >--------------+
   \                /               ¦
    +-------+------+                ¦
            ¦Yes                    ¦
 +----------+-----------+           ¦
 \Ctrl = BINAND(1, Ctrl)/           ¦
  \ CONTROL 12,2; Ctrl /            ¦
   \                  /             ¦
    ¦     WAIT .1     ¦             ¦
    ¦                 ¦             ¦
    +-------+---------+             v
            ¦                       ¦
      /----+---------+              ¦
    / Get data from  ¦              ¦
    ¦ interface      ¦              ¦
    ¦                ¦              ¦
    ¦    STATUS1     ¦              ¦
    ¦    STATUS2     ¦              ¦
    ¦    STATUS3     ¦              ¦
    +-------+--------+              ¦
            ¦                       ¦
            ¦                       ¦
            ¦                       ¦
            ¦                       ¦
            v                       v
            v                          v
    /-------+--------+                 :
  / Get data from    :                 :
  : interface        :                 :
  :                  :                 :
  :    STATUS4       :                 :
  :    STATUS5       :                 :
  :    STATUS6       :                 :
  +---------+--------+                 :
            :                          :
    /-------+--------+                 v
  / Get data from    :                 :
  : interface        :                 :
  :                  :                 :
  :    STATUS7       :                 :
  :    STATUS8       :                 :
  :    STATUS9       :                 :
  +---------+--------+                 :
            :                          :
  +---------+-------+                  :
 /         IF        \ No              v
< STATUS1=STATUS4=    >--------------->:
 \       STATUS7     /                 :
  +---------+-------+                  :
            : Yes                      :
  +---------+-------+                  :
 /         IF        \ Yes             :
<      STATUS1 = 0    >--------------->:
 \                   /                 :
  +---------+-------+                  :
            :No                        v
  +---------+-------+                  :
 /         IF        \No               :
<      STATUS1 < 0    >-------+        :
 \                   /        :        :
  +---------+-------+         :        :
            :Yes              :        :
  +---------+--------+        :        :
  : STATUS1 =        :        :        :
  :65536 + STATUS1   :        :        :
  +---------+--------+        :        v
            :                 :        :
            :<----------------+        :
  +---------+--------+                 :
  : Print "Status    :                 :
  : = ", STATUS1     :                 :
  :------------------:                 :
  :Terminal Output   :                 :
  +---------+-------/                  :
            :                          :
  +---------+--------+                 v
  :Star1_flag =      :                 :
  :BIT(STATUS1,15)   :                 :
  +---------+--------+                 :
            :                          :
  +---------+--------+                 :
  :Star2_flag =      :                 :
  :BIT(STATUS1,14)   :                 :
  +---------+--------+                 :
            v                          v
            v                       v
            ¦                       ¦
    +-------+-------+               ¦
    ¦Star3.flag =   ¦               ¦
    ¦BIT(STATUS1.13)¦               ¦
    +-------+-------+               ¦
            ¦                       ¦
    +-------+-------+               ¦
    ¦ Track1_flag = ¦               ¦
    ¦BIT(STATUS1.12)¦               ¦
    +-------+-------+               ¦
            ¦                       ¦
    +-------+-------+               v
    ¦ Track2_flag = ¦               ¦
    ¦BIT(STATUS1.11)¦               ¦
    +-------+-------+               ¦
            ¦                       ¦
    +-------+-------+               ¦
    ¦ Track3_flag = ¦               ¦
    ¦BIT(STATUS1.10)¦               ¦
    +-------+-------+               ¦
            ¦                       ¦
            ¦<----------------------+
+-----------+----------+
( ENABLE interrupts    )
( from soft keys       )
+-----------+----------+
            ¦
    +-------+-------+
    ¦     RETURN    ¦
    +---------------+


    +---------------+
    ¦***************¦
    ¦ CMD_INTERFACE ¦
    ¦***************¦
    ¦               ¦
    ¦ Output a spec-¦
    ¦ ific command  ¦
    ¦ to interface  ¦
    +-------+-------+
            ¦
    +-------+-------+
    ¦ Menu_flag = 3 ¦
    +-------+-------+
            ¦
    +-------+-------+
    ¦   Ctrl = 2    ¦
    +-------+-------+
            ¦
 +----------+-----------+
 \  CONTROL 12,2; Ctrl  /
  \      WAIT .1       /
   \                 /
    ¦ Ctrl =        ¦
    ¦ BINIOR(1,Ctrl)¦
    +-------+-------+
            ¦
```

```
           v
+----------+-----------+
\  CONTROL 12,2: Ctrl  /
 \                    /
  \                  /
   +-------+-------+
           :
   +-------+-------+
   : Display       :
   : "Sending ",   :
   : SEND_MSG$,    :
   : " to the      :
   : tracker "     :
   :---------------:
   :Terminal Output:
   +-------+-------/
           :
   +-------+------+
  /       IF       \
 <  Test_flag = 0   >------+
  \                /       :
   +-------+------+        :
           :Yes            :
   +-------+-------+       :
   : WAIT .5       :       :
   : Clear the     :       :
   : display line  :       :
   :---------------:       :
   :Terminal Output:       :
   +-------+-------/       :
           :               :
   +-------+-------+       :
   :    RETURN     :       :
   +---------------+       :
                           :
           +<--------------+
           :
   +-------+------+
  / OUTPUT 12 USING\
 < "#,B":Inter_face >
  \                /
   +-------+------+
           :
   +-------+-------+
   :   Time_out    :
   :       =       :
   :   TIMEDATE    :
   +-------+-------+
           :
   +-------+-------+
   :   Time_out    :
   :       =       :
   : Time_out + 7  :
   +-------+-------+
           :
           :
           :
           :
           :
           v
```

```
                                        v
                                +-------+-------+
                                !  Time_out1    !
                                !       =       !
                                ! Time_out + 1  !
                                +-------+-------+
                                        !
                                +-------+-------+
                                ! Time_flag = 0 !
                                +-------+-------+
                                        !
                                        !<---------------------------------+
                                +-------+-------+                          !
                                !***************!                          !
                                !  DO_IT_AGAIN  !                          !
                                !***************!                          !
                                +-------+-------+                          !
                                        !                                  !
                                +-------+-------+                          !
                                !   Time_yet    !                          !
                                !       =       !                          !
                                !   TIMEDATE    !                          !
                                +-------+-------+                          !
                                        !                                  !
                                +-------+------+                           !
                               /       IF       \No                        !
                              <Time_out>Time_out1>------------->+          !
                               \                /               !          ^
                                +-------+------+                !          !
                                        !Yes                    !          !
                                +-------+--------+              !          !
                            Yes/IF Time_yet>      \             !          !
                        +-----<    Time_out OR     >            !          !
                        !      \Time_yet<Time_out1/             !          !
                        !       +-------+--------+              !          !
                        !               ! No                    !          !
                        !       +-------+--------+              !          !
                        v   Yes/IF Time_yet>      \No           !          !
                        +-----<    Time_out AND    >----------->!          !
                        !      \Time_yet<Time_out1/             !          !
                        !       +-------+--------+              !          !
                        !                                       !          !
                        +-------------->!                       !          !
                                +-------+-------+               !          !
                                ! Time_flag = 1 !               !          !
                                +-------+-------+               !          !
                                        !                       !          !
                                        v                       !          !
+-------------------------------------->!<----------------------+          ^
!                               +-------+-------+                          !
!                               !***************!                          !
!                               ! CHECK_TRACKER !                          !
!                               !************** !                          !
!                               +-------+-------+                          !
!                                       !                                  !
!                               +-------+-------+                          !
!                               !    WAIT 1.0   !                          !
!                               +-------+-------+                          !
!                                       !                                  !
                                        v                                  ^
```



```
STATUS 12,5;Tkr_status
(Get tracker
 status from
 the interface)

Tkr_command =
BINAND(3,Tkr_status)
 + 10

SELECT
Tkr_command

case 10:
    GOSUB
    Get_data
    (PAGE 43)

    Ctrl=
    BINAND(2, Ctrl)

    CONTROL 12,2; Ctrl

    Ctrl=
    BINIOR(1, Ctrl)

    CONTROL 12,2; Ctrl

    GOSUB
    Trans_error
    (PAGE 57)

case 11:
    GOSUB
    Trans_error
    (PAGE 57)

case 12:
    GOSUB
    Get_data
    (PAGE 43)
```


IF
Time_flag = 2
No
Yes
Clear send
msg off screen
Terminal Output
RETURN
IF
Time_flag = 0
Yes
No
No
IF
Time_flag = 1
Yes
Time_flag = 2

```
        +---------------+
        ¦***************¦
        ¦   GET_DATA    ¦
        ¦***************¦
        ¦               ¦
        ¦ Recieve and   ¦
        ¦ display the   ¦
        ¦ star data     ¦
        +-------+-------+
                ¦
    +-----------+---------+
    ( DISABLE interrupts  )
    ( from soft keys      )
    +-----------+---------+
                ¦
        +-------+------+
     No/       IF        \
+-----<  Test_flag = 0   >
¦      \                /
¦       +-------+------+
¦               ¦Yes
¦       +-------+-------+
v       ¦      Ctrl     ¦
¦       ¦       =       ¦
¦       ¦BINAND(1, Ctrl)¦
¦       +-------+-------+
¦               ¦
¦    +----------+-----------+
¦    \  CONTROL 12,2; Ctrl  /
¦     \--------------------/
¦      \                 /
v       ¦               ¦
¦       ¦               ¦
¦       +-------+-------+
¦               ¦
¦         /-----+-------+
¦       /  Get Star1_x, ¦
¦       ¦ Star1_y, and  ¦
¦       ¦ Star1_m from  ¦
¦       ¦ the tracker   ¦
¦       +-------+-------+
v               ¦
¦         /-----+-------+
¦       /  Get Star2_x, ¦
¦       ¦ Star2_y, and  ¦
¦       ¦ Star2_m from  ¦
¦       ¦ the tracker   ¦
¦       +-------+-------+
¦               ¦
¦         /-----+-------+
¦       /  Get Star3_x, ¦
v       ¦ Star3_y, and  ¦
¦       ¦ Star3_m from  ¦
¦       ¦ the tracker   ¦
¦       +-------+-------+
¦               ¦
¦               ¦
¦               ¦
¦               ¦
v               v
```

```
v                   v
:         +---------+--------+
:        /         IF         \ No
:      <    Star1_x < 0        >--------+
:        \                    /         :
:         +---------+--------+          :
v                   :Yes                v
:         +---------+---------+         :
:         :     Star1_x       :         :
:         :         =         :         :
:         :65536 + Star1_x    :         :
:         +---------+---------+         :
:                   :                   :
:                   :<------------------+
:         +---------+--------+
:        /         IF         \ No
v      <    Star1_y < 0        >--------+
:        \                    /         :
:         +---------+--------+          :
:                   :Yes                v
:         +---------+---------+         :
:         :     Star1_y       :         :
:         :         =         :         :
:         :65536 + Star1_y    :         :
:         +---------+---------+         :
:                   :                   :
v                   :<------------------+
:         +---------+--------+
:        /         IF         \ No
:      <    Star1_m < 0        >--------+
:        \                    /         :
:         +---------+--------+          :
:                   :Yes                v
:         +---------+---------+         :
:         :     Star1_m       :         :
:         :         =         :         :
v         :65536 + Star1_m    :         :
:         +---------+---------+         :
:                   :                   :
:                   :<------------------+
:         +---------+--------+
:        /         IF         \ No
:      <    Star2_x < 0        >--------+
:        \                    /         :
:         +---------+--------+          :
:                   :Yes                v
v         +---------+---------+         :
:         :     Star2_x       :         :
:         :         =         :         :
:         :65536 + Star2_x    :         :
:         +---------+---------+         :
:                   :                   :
:                   :<------------------+
:         +---------+--------+
:        /         IF         \ No
:      <    Star2_y < 0        >--------+
:        \                    /         :
:         +---------+--------+          :
:                   :Yes                :
v                   v                   v
```

```
v                 v                 v
|        +--------+--------+        |
|        |     Star2_y     |        |
|        |        =        |        |
|        |65536 + Star2_y  |        |
|        +--------+--------+        |
|                 |                 |
|                 |<----------------+
v        +--------+-------+
|       /        IF        \ No
|      <   Star2_m < 0       >-------+
|       \                  /        |
|        +--------+-------+          |
|                 |Yes              v
|        +--------+--------+        |
|        |     Star2_m     |        |
|        |        =        |        |
|        |65536 + Star2_m  |        |
v        +--------+--------+        |
|                 |                 |
|                 |<----------------+
|        +--------+-------+
|       /        IF        \ No
|      <   Star3_x < 0       >-------+
|       \                  /        |
|        +--------+-------+          |
|                 |Yes              v
|        +--------+--------+        |
v        |     Star3_x     |        |
|        |        =        |        |
|        |65536 + Star3_x  |        |
|        +--------+--------+        |
|                 |                 |
|                 |<----------------+
|        +--------+-------+
|       /        IF        \ No
|      <   Star3_y < 0       >-------+
|       \                  /        |
v        +--------+-------+          |
|                 |Yes              v
|        +--------+--------+        |
|        |     Star3_y     |        |
|        |        =        |        |
|        |65536 + Star3_y  |        |
|        +--------+--------+        |
|                 |                 |
|                 |<----------------+
|        +--------+-------+
v       /        IF        \ No
|      <   Star3_m < 0       >-------+
|       \                  /        |
|        +--------+-------+          |
|                 |Yes              v
|        +--------+--------+        |
|        |     Star3_m     |        |
|        |        =        |        |
|        |65536 + Star3_m  |        |
|        +--------+--------+        |
|                 |                 |
v                 v                 v
```

```
v               v                v
|               |<---------------+
|       +-------+-------+
|       | Star1_x =     |
|       | Star1_x / 256 |
|       +-------+-------+
|               |
|       +-------+-------+
|       | Star1_y =     |
|       | Star1_y / 256 |
v       +-------+-------+
|               |
|       +-------+-------+
|       | Star1_m =     |
|       | Star1_m / 256 |
|       +-------+-------+
|               |
|       +-------+-------+
|       | Star2_x =     |
|       | Star2_x / 256 |
v       +-------+-------+
|               |
|       +-------+-------+
|       | Star2_y =     |
|       | Star2_y / 256 |
|       +-------+-------+
|               |
|       +-------+-------+
|       | Star2_m =     |
|       | Star2_m / 256 |
v       +-------+-------+
|               |
|       +-------+-------+
|       | Star3_x =     |
|       | Star3_x / 256 |
|       +-------+-------+
|               |
|       +-------+-------+
|       | Star3_y =     |
|       | Star3_y / 256 |
v       +-------+-------+
|               |
|       +-------+-------+
|       | Star3_m =     |
|       | Star3_m / 256 |
|       +-------+-------+
|               |
|               +----------------+
|                                |
|                                |
+-------------->|                |
        +-------+-------+        |
        | Star1_x =     |        |
        | 11+ Data_count|        |
        +-------+-------+        |
                |                |
                |                |
                |                |
                v                v
```

```
         v                v
+--------+--------+       :
: Star1_y =       :       :
: 12+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       :
: Star1_m =       :       :
: 13+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       v
: Star2_x =       :       :
: 14+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       :
: Star2_y =       :       :
: 15+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       v
: Star2_m =       :       :
: 16+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       :
: Star3_x =       :       :
: 17+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       v
: Star3_y =       :       :
: 18+ Data_count  :       :
+--------+--------+       :
         :                :
+--------+--------+       :
: Star3_m =       :       :
: 19+ Data_count  :       :
+--------+--------+       :
         :                :
         :<---------------+
+--------+--------+
: Datat =         :
: (3600 * Hour +  :
:  60 * Minute +  :
:  Second -       :
:  TIMEDATE ) +   :
:  ABS(Datat)     :
+--------+--------+
         :
+--------+--------+
: Data_time =     :
: TIMEDATE +      :
: Datat           :
+--------+--------+
         :
         :
         :
         v
```

```
                v
+-------+-------+
| Data_time =   |
| INT( Data_time|
|  * 100) / 100 |
+-------+-------+
        |
+-------+-------+
|    Hour =     |
|    Data_time  |
|    DIV 3600   |
+-------+-------+
        |
+-------+-------+
|   Minute =    |
|   Data_time   |
|MOD 3600 DIV 60|
+-------+-------+
        |
+-------+-------+
|   Second =    |
|   Data_time   |
|    MOD 60     |
+-------+-------+
        |
+-------+-------+
| Display the   |
| update toggle |
|---------------|
|Terminal Output|
+-------+-------/
        |
+-------+-------+
|    Display    |
|    Star1_x    |
|    Star1_y    |
|    Star1_m    |
|---------------|
|Terminal Output|
+-------+-------/
        |
+-------+-------+
|    Display    |
|    Star2_x    |
|    Star2_y    |
|    Star2_m    |
|---------------|
|Terminal Output|
+-------+-------/
        |
+-------+-------+
|    Display    |
|    Star3_x    |
|    Star3_y    |
|    Star3_m    |
|---------------|
|Terminal Output|
+-------+-------/
        |
        v
```

```
                        v
                +-------+------+
           Yes /       IF       \
+-------------< Tak_data_flag = 0>
¦              \                /
¦               +-------+------+
¦                       ¦ No
¦               +-------+-------+
¦               ¦ Data_count =  ¦
v               ¦ 1 + Data_count¦
¦               +-------+-------+
¦                       ¦
¦               +-------+------+
¦            No/       IF       \
¦<-----------<    Data_count <= >
¦              \    Max_dat     /
¦               +-------+------+
¦                       ¦ Yes
¦          +------------+-------------+
v          ¦ Star_data(Data_count,1)  ¦
¦          ¦            =             ¦
¦          ¦        Star1_x           ¦
¦          +------------+-------------+
¦                       ¦
¦          +------------+-------------+
¦          ¦ Star_data(Data_count,2)  ¦
¦          ¦            =             ¦
¦          ¦        Star1_y           ¦
¦          +------------+-------------+
v                       ¦
¦          +------------+-------------+
¦          ¦ Star_data(Data_count,3)  ¦
¦          ¦            =             ¦
¦          ¦        Star1_m           ¦
¦          +------------+-------------+
¦                       ¦
¦          +------------+-------------+
¦          ¦ Star_data(Data_count,4)  ¦
¦          ¦            =             ¦
v          ¦        Star2_x           ¦
¦          +------------+-------------+
¦                       ¦
¦          +------------+-------------+
¦          ¦ Star_data(Data_count,5)  ¦
¦          ¦            =             ¦
¦          ¦        Star2_y           ¦
¦          +------------+-------------+
¦                       ¦
¦          +------------+-------------+
v          ¦ Star_data(Data_count,6)  ¦
¦          ¦            =             ¦
¦          ¦        Star2_m           ¦
¦          +------------+-------------+
¦                       ¦
¦          +------------+-------------+
¦          ¦ Star_data(Data_count,7)  ¦
¦          ¦            =             ¦
¦          ¦        Star3_x           ¦
¦          +------------+-------------+
v                       v
```

```
           v                      v
           :                      :
           :          +-----------+-----------------+
           :          : Star_data(Data_count,8)     :
           :          :           =                 :
           :          :        Star3_y              :
           :          +-----------+-----------------+
           :                      :
           :          +-----------+-----------------+
           :          : Star_data(Data_count,9)     :
           :          :           =                 :
           v          :        Star3_m              :
           :          +-----------+-----------------+
           :                      :
           :          +-----------+-----------------+
           :          : Star_data(Data_count,10)    :
           :          :           =                 :
           :          :          Hour               :
           :          +-----------+-----------------+
           :                      :
           :          +-----------+-----------------+
           v          : Star_data(Data_count,11)    :
           :          :           =                 :
           :          :         Minute              :
           :          +-----------+-----------------+
           :                      :
           :          +-----------+-----------------+
           :          : Star_data(Data_count,12)    :
           :          :           =                 :
           :          :        Second               :
           :          +-----------+-----------------+
           v                      :
           :                +-----+-------+
           :                : Position the :
           :                : cursor at loc :
           :                : of Display    :
           :                : set number    :
           :                :---------------:
           :                :Terminal Output:
           :                +-----+-------/
           :                      :
           v                +-----+-------+
           :               /      IF       \ No
           :              <  Data_count > 0 >------+
           :               \               /       :
           :                +-----+-------+        :
           :                      : Yes            :
           :                +-----+-------+        :
           :                : Display      :       :
           :                : Data_count   :       :
           :                :--------------:       :
           v                :Terminal Output:      v
           :                +-----+-------/        :
           :                      :                :
           :                      :                :
           :                      :                :
           :                      :                :
           v                      v                v
```

```
v                         v                v
¦                         ¦                ¦
¦                         ¦<---------------+
¦                +--------+-------+
¦               /        IF        \ No
¦              <  Data_count = 0    >------+
¦               \                  /       ¦
¦                +--------+-------+        ¦
¦                         ¦ Yes            ¦
v                +--------+--------+       v
¦                ¦ Display         ¦       ¦
¦                ¦ "             " ¦       ¦
¦                ¦-----------------¦       ¦
¦                ¦Terminal Output  ¦       ¦
¦                +--------+-------/        ¦
¦                         ¦                ¦
¦                         ¦<---------------+
¦                +--------+-------+
¦               /        IF        \ No
v              <    Data_count =    >------+
¦               \     Max_dat      /       ¦
¦                +--------+-------+        ¦
¦                         ¦ Yes            ¦
¦                +--------+--------+       ¦
¦                ¦      GOSUB      ¦       ¦
¦                ¦   Write_data    ¦       ¦
¦                ¦   (PAGE 52)     ¦       ¦
¦                +--------+--------+       ¦
¦                         ¦                ¦
¦                         v                ¦
+------------------------>¦<---------------+
                +--------+--------+
                ¦*****************¦
                ¦   END_GET_DATA  ¦
                ¦*****************¦
                +--------+--------+
                         ¦
            +------------+-----------+
            (   ENABLE interrupts    )
            (  from soft keys        )
            +------------+-----------+
                         ¦
                +--------+--------+
                ¦     RETURN      ¦
                +-----------------+
+---------------+
|***************|
|  WRITE_DATA   |
|***************|
|               |
| Write the star|
| data to the   |
| output file   |
+-------+-------+
        |
+-------+-------+
|    ON ERROR   |
|     GOTO      |
|   Error_tst   |
|               |
| (trap any     |
|  errors that  |
|  may occur in |
|  this routine)|
+-------+-------+
        |
+-------+-------+
|    Number$    |
|       =       |
| VAL$(Nfiles)  |
+-------+-------+
        |
+-------+-------+
|File_string$(6)|
|  = Number$(1) |
+-------+-------+
        |
+-------+-------+
| Display       |
| "Writing data |
|  to file >",  |
|  Nfiles       |
|---------------|
|Terminal Output|
+-------+-------/
        |
+-------+-------+
| MASS STORAGE  |
| IS...         |
|               |
| assign the    |
| right disc    |
| drive for data|
+-------+-------+
        |
+-------+-------+
|  CREATE BDAT  |
|               |
| (Open the data|
|  file)        |
+-------+-------+
        |
        v
```

```
                v
        +-------+-------+
        ! ASSIGN an     !
        ! output path   !
        ! name to file  !
        ! on disk       !
        +-------+-------+
                !
        +-------+-----\
        ! WRITE        \
        ! Star_data(*)  !
        ! to the file   !
        +-------+-------+
                !
        +-------+-------+
        ! CLOSE the     !
        ! data file     !
        +-------+-------+
                !
        +-------+-------+
        !    Nfiles     !
        !       =       !
        ! 1 + Nfiles    !
        +-------+-------+
                !
        +-------+-------+
        ! Data_count = 0!
        +-------+-------+
                !
        +-------+-------+
        !   OFF ERROR   !
        ! turn off the  !
        ! error trapping!
        +-------+-------+
                !
        +-------+-------+
        ! Clear the     !
        ! display line  !
        !---------------!
        !Terminal Output!
        +-------+------/
                !
        +-------+-------+
        !    RETURN     !
        +---------------+
        +----------------+
        |****************|
        |   ERROR_TST    |
        |****************|
        | Trap any errs  |
        | that occur in  |
        | the data tak-  |
        | ing area       |
        +-------+--------+
                |
        +-------+--------+
        | Beep the       |
        | terminal bell  |
        |----------------|
        |Terminal Output |
        +-------+-------/
                |
        +-------+--------+
        |  OFF ERROR     |
        |                |
        | turn off error |
        | trapping       |
        +-------+--------+
                |
        +-------+-------+
       /       IF        \ No
      <     ERRN = 54     >------+
       \                 /       |
        +-------+-------+        |
                | Yes            |
        +-------+--------+       |
        | Display "This  |       |
        | file already   |       |
        | exists"        |       |
        |----------------|       v
        |Terminal Output |       |
        +-------+-------/        |
                |                |
        +-------+--------+       |
        | PAUSE          |       |
        | Clear the      |       |
        | display line   |       |
        |----------------|       |
        |Terminal Output |       |
        +-------+-------/        v
                |                |
         /------+--------+       |
        |  User Input    |       |
        |----------------|       |
        | "Please input  |       |
        |  initial data  |       |
        |  file # > "    |       |
        |                |       |
        |  Read Nfiles   |       |
        +-------+--------+       v
                |                |
                |                |
                |                |
                |                |
                v                v
```

```
          v                v
  +-------+-------+        ¦
 /        IF       \  No   ¦
< 0 < Nfiles < 99   >----->¦
 \                 /       ¦
  +-------+-------+        ¦
          ¦ Yes            ¦
  +-------+--------+       ¦
  ¦ Max_num_files  ¦       ¦
  ¦       =        ¦       v
  ¦Max_files+Nfiles¦       ¦
  +-------+--------+       ¦
          ¦                ¦
  +-------+-------+        ¦
  ¦     GOTO      ¦        ¦
  ¦  Write_data   ¦        ¦
  ¦   (PAGE 52)   ¦        ¦
  +---------------+        ¦
                           ¦
          ¦<---------------+
  +-------+-------+
 /        IF       \  No
<      ERRN = 64    >------+
 \                 /       ¦
  +-------+-------+        ¦
          ¦ Yes            ¦
  +-------+-------+        ¦
  ¦ Display "Disc ¦        ¦
  ¦ is full"      ¦        ¦
  ¦---------------¦        ¦
  ¦Terminal Output¦        ¦
  +-------+-------/        ¦
          ¦                ¦
  +-------+-------+        v
  ¦    WAIT .5    ¦        ¦
  ¦ "Press <CONT>"¦        ¦
  ¦---------------¦        ¦
  ¦Terminal Output¦        ¦
  +-------+-------/        ¦
          ¦                ¦
  +-------+-------+        ¦
  ¦ Clear the     ¦        ¦
  ¦ display line  ¦        ¦
  ¦---------------¦        v
  ¦Terminal Output¦        ¦
  +-------+-------/        ¦
          ¦                ¦
  +-------+-------+        ¦
  ¦     GOTO      ¦        ¦
  ¦  Write_data   ¦        ¦
  ¦   (PAGE 52)   ¦        ¦
  +---------------+        ¦
                           ¦
          ¦<---------------+
  +-------+-------+
 /        IF       \No
<      ERRN = 80    >------+
 \                 /       ¦
  +-------+-------+        ¦
          v Yes            v
```

```
         v                v
         ¦                ¦
+--------+--------+       ¦
¦ Display "There¦       ¦
¦ isn't a cor-    ¦       ¦
¦ rect disc in    ¦       ¦
¦ the right       ¦       ¦
¦ drive"          ¦       ¦
¦-----------------¦       ¦
¦Terminal Output¦       ¦
+--------+-------/        ¦
         ¦                ¦
+--------+--------+       ¦
¦ WAIT .5         ¦       ¦
¦ Display         ¦       ¦
¦ "Press <CONT>"¦       ¦
¦-----------------¦       ¦
¦Terminal Output¦       ¦
+--------+-------/        ¦
         ¦                ¦
+--------+--------+       ¦
¦      PAUSE      ¦       ¦
¦ Clear the       ¦       ¦
¦ display line    ¦       ¦
¦-----------------¦       ¦
¦Terminal Output¦       ¦
+--------+-------/        ¦
         ¦                ¦
+--------+--------+       ¦
¦      GOTO       ¦       ¦
¦   Write_data    ¦       ¦
¦   (PAGE 52)     ¦       ¦
+-----------------+       ¦
                          ¦
         ¦<---------------+
+--------+--------+
¦ Display         ¦
¦ "Unexpected     ¦
¦  error..."      ¦
¦-----------------¦
¦Terminal Output¦
+--------+-------/
         ¦
+--------+--------+
¦ PAUSE           ¦
¦ Clear the       ¦
¦ display line    ¦
¦-----------------¦
¦Terminal Output¦
+--------+-------/
         ¦
+--------+--------+
¦     RETURN      ¦
+-----------------+
              +---------------+
              |***************|
              |  TRANS_ERROR  |
              |***************|
              |               |
              | Display where |
              | the Xmit error|
              | came from     |
              +-------+-------+
                      |
              +-------+------+
             /        IF      \No
            <   Menu_flag = 0  >-------+
             \                /        |
              +-------+------+         |
                      |                |
              +-------+-------+        |
              |    Err_msg$   |        |
              |       =       |        |
              |"             "|        |
              +-------+-------+        |
                      |                |
                      |<---------------+
              +-------+------+
             /        IF      \No
            <   Menu_flag = 1  >-------+
             \                /        |
              +-------+------+         |
                      | Yes            |
              +-------+-------+        |
              |    Err_msg$   |        |
              |       =       |        |
              | "Menu 1 Xmit" |        |
              +-------+-------+        |
                      |                |
                      |<---------------+
              +-------+------+
             /        IF      \No
            <   Menu_flag = 2  >-------+
             \                /        |
              +-------+------+         |
                      |Yes             |
              +-------+-------+        |
              |    Err_msg$   |        |
              |       =       |        |
              | "Menu 2 Xmit" |        |
              +-------+-------+        |
                      |                |
                      |<---------------+
              +-------+------+
             /        IF      \No
            <  Menu_flag = 3   >-------+
             \                /        |
              +-------+------+         |
                      |Yes             |
                      |                |
                      |                |
                      v                v
            v                 v
   +--------+--------+        |
   |    Err_msg$     |        |
   |        =        |        |
   | "Command        |        |
   |  Interface      |        |
   |  Xmit error"    |        |
   +--------+--------+        |
            |                 |
            |<----------------+
   +--------+--------+
   | Clear the       |
   | display line    |
   |-----------------|
   |Terminal Output  |
   +--------+-------/
            |
   +--------+--------+
   | Display         |
   |   Err_msg$      |
   |-----------------|
   |Terminal Output  |
   +--------+-------/
            |
            |
   +--------+--------+
   |    Ctrl =       |
   |BINAND(2, Ctrl)  |
   +--------+--------+
            |
+-----------+-------------+
\  CONTROL 12,2; Ctrl    /
 \---------------------/
  \                   /
   |                 |
   |                 |
   +--------+--------+
            |
   +--------+--------+
   |    Ctrl =       |
   |BINIOR(1, Ctrl)  |
   +--------+--------+
            |
+-----------+-------------+
\  CONTROL 12,2; Ctrl    /
 \---------------------/
  \                   /
   |                 |
   |                 |
   +--------+--------+
            |
   +--------+--------+
   |  Freq1 = 4000   |
   +--------+--------+
            |
   +--------+--------+
   |  Freq2 = 1000   |
   +--------+--------+
            |
            v
```

```
                v
        +-------+-------+
        ¦  Bnumber = 2  ¦
        +-------+-------+
                ¦
        +-------+-------+
        ¦  Btime = .2   ¦
        +-------+-------+
                ¦
        +-------+-------+
        ¦ Dfreq = (Freq2¦
        ¦ - Freq1) /    ¦
        ¦ Bnumber       ¦
        +-------+-------+
                ¦
        +-------+-------+
        ¦     F = 0     ¦
        +-------+-------+
                ¦
+-------------->¦
¦       +-------+-------+
¦       ¦ Bfreq = Freq1 ¦
¦       ¦ + (Dfreq * F) ¦
¦       +-------+-------+
¦               ¦
¦       +-------+-------+
¦       ¦ BEEP the      ¦
¦       ¦ terminal bell ¦
¦       ¦ @ Bfreq for   ¦
^       ¦ Btime         ¦
¦       ¦---------------¦
¦       ¦Terminal Output¦
¦       +-------+------/
¦               ¦
¦       +-------+-------+
¦       ¦   F = F + 1   ¦
¦       +-------+-------+
¦               ¦
¦       +-------+------+
¦   No /       IF       \
+------<  F = Bnumber - 1 >
        \               /
        +-------+------+
                ¦ Yes
        +-------+-------+
        ¦ Clear the     ¦
        ¦ display line  ¦
        ¦---------------¦
        ¦Terminal Output¦
        +-------+------/
                ¦
        +-------+-------+
        ¦    RETURN     ¦
        +---------------+
+---------------+
|***************|
| SET_UP_TABLE  |
|***************|
|               |
| Set up the    |
| values for a  |
| command table |
+-------+-------+
        |
+-------+-------+
|    Ctble(1)   |
|       =       |
|      224      |
+-------+-------+
        |
+-------+-------+
|    Ctble(2)   |
|       =       |
|      152      |
+-------+-------+
        |
+-------+-------+
|    Ctble(3)   |
|       =       |
|      120      |
+-------+-------+
        |
+-------+-------+
|    Ctble(4)   |
|       =       |
|       84      |
+-------+-------+
        |
+-------+-------+
|    Ctble(5)   |
|       =       |
|      180      |
+-------+-------+
        |
+-------+-------+
|    Ctble(6)   |
|       =       |
|      204      |
+-------+-------+
        |
+-------+-------+
|    Ctble(7)   |
|       =       |
|       44      |
+-------+-------+
        |
+-------+-------+
|    Ctble(8)   |
|       =       |
|      210      |
+-------+-------+
        |
        |
        v
```

```
                 v
    +-------+--------+
    !    Ctble(9)    !
    !       =        !
    !       50       !
    +-------+--------+
            !
    +-------+--------+
    !    Ctble(10)   !
    !       =        !
    !       74       !
    +-------+--------+
            !
    +-------+--------+
    !    Ctble(11)   !
    !       =        !
    !      172       !
    +-------+--------+
            !
    +-------+--------+
    !    Ctble(12)   !
    !       =        !
    !      136       !
    +-------+- ------+
            !
    +-------+--------+
    !    Ctble(13)   !
    !       =        !
    !      102       !
    +-------+--------+
            !
    +-------+--------+
    !    Ctble(14)   !
    !       =        !
    !       30       !
    +-------+--------+
            !
    +-------+--------+
    !    Ctble(15)   !
    !       =        !
    !      254       !
    +-------+--------+
            !
    +-------+--------+
    !     RETURN     !
    +----------------+
         +---------------+
         |***************|
         |     NO_OP     |
         |***************|
         | If the user   |
         | inputs an     |
         | INVALID comm- |
         | and...        |
         +-------+-------+
                 |
         +-------+-------+
         | Beep the      |
         | terminal bell |
         |---------------|
         |Terminal Output|
         +-------+-------/
                 |
         +-------+-------+
         |    Err_msg$   |
         |       =       |
         |"             "|
         +-------+-------+
                 |
         +-------+-------+
        /       IF        \ No
       <  Menu_flag = 1    >-------+
        \                 /        |
         +-------+-------+         |
                 |Yes              |
         +-------+-------+         |
         |    Err_msg$   |         |
         |       =       |         |
         |"from Menu #1" |         |
         +-------+-------+         |
                 |                 |
                 |<----------------+
         +-------+-------+
        /       IF        \ No
       <  Menu_flag = 2    >-------+
        \                 /        |
         +-------+-------+         |
                 |Yes              |
         +-------+-------+         |
         |    Err_msg$   |         |
         |       =       |         |
         |"from Menu #2" |         |
         +-------+-------+         |
                 |                 |
                 |<----------------+
         +-------+-------+
         | Display       |
         | "INVALID      |
         |  Command      |
         |  Entry"       |
         |---------------|
         |Terminal Output|
         +-------+-------/
                 |
                 v
        v
+-------+-------+
! WAIT .5       !
! Display       !
!  Err_msg$     !
!---------------!
!Terminal Output!
+-------+------/
        !
+-------+-------+
! WAIT .5       !
! Clear the     !
! display line  !
!---------------!
!Terminal Output!
+-------+------/
        !
+-------+-------+
!     RETURN    !
+---------------+
+----------------+
|****************|
|    SHUTDOWN    |
|****************|
| This routine   |
| allows the     |
| user a clean   |
| exit !!        |
+-------+--------+
        |
+-------+--------+
|    OFF KEY     |
|                |
| turn off all   |
| assigned func- |
| tion keys      |
+-------+--------+
        |
+-------+--------+
| Printer is 1   |
+-------+--------+
        |
+-------+--------+
| Clear the      |
| screen         |
|----------------|
|Terminal Output |
+-------+-------/
        |
+-------+--------+
| Display        |
| "PROGRAM       |
|  TERMINATED"   |
|----------------|
|Terminal Output |
+-------+-------/
        |
+-------+--------+
|      END       |
+----------------+
```

Section I-3

Section I-3
DATA INPUT PROGRAM LISTING

```
LOCATION OBJECT CODE LINE     SOURCE LINE

                        1 "6805"LIST
                        2 *                   NRL Tracker Interface
                        3 *                Data Input to 6805 Program
                        4 *                      April 2, 1984
                        5
                        6 *                 Revised Sept  9,1984    3:10 PM
                        7
              <0000>    8 PORTA           EQU        0000H           LSByte output port
              <0001>    9 PORTB           EQU        0001H           MSByte output port
              <0002>   10 PORTC           EQU        0002H           Control port
              <0003>   11 PORTD           EQU        0003H           Data input port
              <0011>   12 LIMIT           EQU        0011H           Number of data bytes
              <0010>   13 TABLE           EQU        0010H           Beginning of data table
              <0008>   14 TDATA           EQU        0008H           Timer data register
              <0009>   15 TCONT           EQU        0009H           Timer Control register
                       16
                       17                 NAME       "NRL_DATA"
                       18
                       19                 ORG        0100H
                       20
    0100 A6 FF         21 INIT            LDA        #0FFH           Initialize
    0102 B7 04         22                 STA        004H               DDRA
    0104 B7 05         23                 STA        005H               DDRB
    0106 A6 85         24                 LDA        #085H
    0108 B7 06         25                 STA        006H               DDRC
    010A 3F 00         26                 CLR        PORTA           Put zero's
    010C 3F 01         27                 CLR        PORTB             in Ports
    010E 3F 02         28                 CLR        PORTC
    0110 10 02         29                 BSET       0,PORTC         Set PFLG hi
    0112 14 02         30                 BSET       2,PORTC         Set not_DAT_RDY hi
    0114 5F            31                 CLRX                       Clear TABLE offset
    0115 9A            32                 CLI                        Enable interrupts
                       33
    0116 9D            34 WAIT            NOP                        Loop till interrupt
    0117 20 FD         35                 BRA        WAIT
                       36
                       37 * Receive data from tracker and store in table.
                       38 * Interrupts are disabled by IRQ.
                       39
                       40
    0119 1F 02         41 REC             BCLR       7,PORTC         Set Byte-control=0
    011B B6 03         42 READ            LDA        PORTD           Transfer byte 1 to
    011D E7 10         43                 STA        TABLE,X           data table.
    011F 5C            44                 INX                        Increment to next byte
    0120 1E 02         45                 BSET       7,PORTC         Set Byte-control=1
    0122 B6 03         46                 LDA        PORTD           Transfer byte 2 to
    0124 E7 10         47                 STA        TABLE,X           data table.
    0126 5C            48                 INX                        Increment to next byte
    0127 1F 02         49                 BCLR       7,PORTC         Set Byte-control=0
    0129 A3 11         50                 CPX        #LIMIT
    012B 22 04         51                 BHI        TRANSFER        Branch if last data
    012D BF 7D         52                 STX        07DH            Save count for return
    012F 9A            53                 CLI                        Enable interrupts
    0130 80            54                 RTI                        Go wait for next word.
                       55
                       56 * Transmit data from the data table to the HP9816 computer
                       57
```

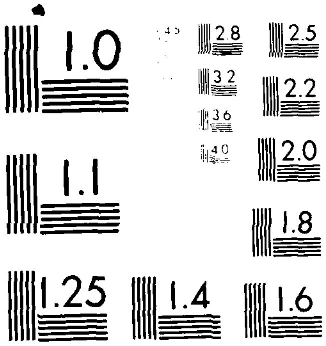
```
LOCATION OBJECT CODE LINE     SOURCE LINE

    0131 15 02          58 TRANSFER        BCLR        2,PORTC         Set not_Data_ready LO
    0133 5F             59                 CLRX
    0134 0202 FD        60 LOOP1           BRSET       1,PORTC,LOOP1   Loop till PCTL=1
    0137 E6 10          61 LOOP2           LDA         TABLE,X         Get LSbyte for out
    0139 B7 00          62                 STA         PORTA
    013B 5C             63                 INCX                        Increment to next byte
    013C E6 10          64                 LDA         TABLE,X         Get MSbyte for out
    013E B7 01          65                 STA         PORTB
    0140 5C             66                 INCX                        Increment to next byte
    0141 11 02          67                 BCLR        0,PORTC         Set PFLG low
    0143 0302 FD        68 LOOP3           BRCLR       1,PORTC,LOOP3   Loop till PCTL=0
    0146 14 02          69                 BSET        2,PORTC         Set not_Data_ready HI
    0148 10 02          70                 BSET        0,PORTC         Set PFLAG high
    014A 0202 FD        71 LOOP4           BRSET       1,PORTC,LOOP4   Loop till PCTL1
    014D A3 11          72                 CMPX        #LIMIT
    014F 23 E6          73                 BLS         LOOP2           Loop back if more data
    0151 11 02          74                 BCLR        0,PORTC         Set PFLAG low
    0153 A6 DF          75                 LDA         #0DFH           Delay for 9816
    0155 4A             76 LOOP5           DECA
    0156 26 FD          77                 BNE         LOOP5
    0158 10 02          78                 BSET        0,PORTC         Set PFLAG back high
    015A 9A             79                 CLI                         Enable interrupts
    015B 80             80                 RTI
                        81
                        82                 ORG         0F38H
    0F38 00             83                 FCB         0000
                        84
                        85                 ORG         0FF8H
    0FF8 01000119       86                 FDB         INIT,REC,INIT,INIT
                        87
                        88                 END

Errors=    0
```

```
FILE: NRL_DATA:NRL885    CROSS REFERENCE TABLE           PAGE   3

LINE#   SYMBOL          TYPE      REFERENCES

   21   INIT               A  86,86,86
   12   LIMIT              A  50,72
   60   LOOP1              A  60
   61   LOOP2              A  73
   68   LOOP3              A  68
   71   LOOP4              A  71
   76   LOOP5              A  77
    8   PORTA              A  26,62
    9   PORTB              A  27,65
   10   PORTC              A  28,29,30,41,45,49,58,60,67,68,69,70,71,74,78
   11   PORTD              A  42,46
   42   READ               A
   41   REC                A  86
   13   TABLE              A  43,47,61,64
   15   TCONT              A
   14   TDATA              A
   58   TRANSFER           A  51
   34   WAIT               A  35
```

Section I-4

Section I-4
COMMAND OUTPUT PROGRAM LISTING

AD-A162 778 RADIATION-HARD BREADBOARD STAR TRACKER ATTACHMENT 1(U) 2/2
BALL AEROSPACE SYSTEMS DIV BOULDER CO
M W HUBBARD ET AL SEP 85 BASD/F85-03-1
UNCLASSIFIED N00014-82-6(C)-2488 F/G 9/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
LOCATION OBJECT CODE LINE     SOURCE LINE

                        1 "6805",LIST
                        2 *                    NRL Tracker Interface
                        3 *                  Command Output To Tracker
                        4 *                       April 30, 1984
                        5
                        6 *                    Revised Sept 10, 1984   3:00 PM
                        7
              <0000>    8 PORTA         EQU             0000H           Control Port
              <0001>    9 PORTB         EQU             0001H           Serial Output (bit 0)
              <0002>   10 PORTC         EQU             0002H           LSByte Input Port
              <0003>   11 PORTD         EQU             0003H           MSByte Input Port
              <0008>   12 TDATA         EQU             0008H           Timer Data Register
              <0009>   13 TCONT         EQU             0009H           Timer Control Register
              <0010>   14 TREG          EQU             0010H           Temp Reg For Command
              <0011>   15 COUNT         EQU             0011H           Bit Counter
              <0012>   16 DCOUNT1       EQU             0012H
              <0013>   17 DCOUNT2       EQU             0013H
              <0014>   18 DCOUNT3       EQU             0014H
                       19
                       20               NAME            "NRL_CMD"
                       21
                       22               ORG             0100H
                       23
    0100 A6 D9         24 INIT          LDA             #0D9H           Initialize
    0102 B7 04         25               STA             0004H             DDRA
    0104 A6 FF         26               LDA             #0FFH
    0106 B7 05         27               STA             0005H             DDRB
    0108 3F 06         28               CLR             0006H             DDRC
    010A 3F 00         29               CLR             PORTA           Put zero's
    010C 3F 01         30               CLR             PORTB             in ports
    010E 3F 02         31               CLR             PORTC
    0110 10 00         32               BSET            0,PORTA         Set PFLG2 hi
    0112 A6 77         33               LDA             #077H           Disable TIMER IRQ's
    0114 B7 09         34               STA             TCONT             and start timer clk
                       35
    0116 0B00 FD       36 START         BRCLR           5,PORTA,START   Loop till CTL0=1
                       37 ;                                             9816 has a command
                       38
    0119 0200 FD       39 LOOP1         BRSET           1,PORTA,LOOP1   Loop till PCTL=1
                       40 ;                                             valid command
                       41
    011C 11 00         42               BCLR            0,PORTA         Set PFLG2 low
                       43 ;                                             command acknowledge
                       44
    011E 0300 FD       45 PCTL1         BRCLR           1,PORTA,PCTL1   Loop till PCTL=0
                       46 ;                                             command present
                       47
    0121 B6 02         48               LDA             PORTC           Get command
    0123 B7 10         49               STA             TREG            Save command
    0125 10 00         50               BSET            0,PORTA         Set PFLG hi
                       51 ;                                             data acknowledge
                       52
    0127 0200 FD       53 PCTL0         BRSET           1,PORTA,PCTL0   Loop till PCTL=1
                       54 ;                                             9816 acknowledges data ack
                       55
    012A CD 01A1       56               JSR             DELAY           Wait ~80 us
    012D 11 00         57               BCLR            0,PORTA         Set PFLG low
```

```
LOCATION OBJECT CODE LINE     SOURCE LINE

                       58 ;                                         remove data ack
                       59
   012F A6 05          60                 LDA       #05H            Loop delay 4 times
   0.31 AE FF          61 LOOP7           LDX       #0FFH           Setup delay
   0 33 CD 01A3        62                 JSR       DELAY2            for ~10 ms
   0136 4A             63                 DECA
   0137 26 F8          64                 BNE       LOOP7           Loop till A=0
                       65
   0139 10 00          66                 BSET      0,PORTA         Set PFLG hi
   013B CD 0166        67                 JSR       OUTPUT          Go to OUTPUT 1
   013E CD 0154        68                 JSR       LOOP9           Ignore first mismatch
   0141 CD 0166        69                 JSR       OUTPUT          Go to OUTPUT 2
                       70
                       71
   0144 0500 FD        72 LOOP6           BRCLR     2,PORTA,LOOP6   Wait till ACK hi
   0147 A6 C8          73                 LDA       #0C8H           Preset timer counter
   0149 B7 08          74                 STA       TDATA             to 200d.
   014B 0500 3E        75 LOOP2           BRCLR     2,PORTA,ERROR   Test for error ACK=0
   014E B6 08          76                 LDA       TDATA           Test for timeout
   0150 26 F9          77                 BNE       LOOP2           Still waiting
   0152 20 C2          78                 BRA       START           Command OK, start over
                       79
   0154 0500 FD        80 LOOP9           BRCLR     2,PORTA,LOOP9   Wait till ACK hi
   0157 A6 C8          81                 LDA       #0C8H           Preset timer counter
   0159 B7 08          82                 STA       TDATA             to 200d.
   015B 0500 04        83 LOOP10          BRCLR     2,PORTA,LOOP11  Test for error ACK=0
   015E B6 08          84                 LDA       TDATA           Test for timeout
   0160 26 F9          85                 BNE       LOOP10          Still waiting
   0162 0500 FD        86 LOOP11          BRCLR     2,PORTA,LOOP11  wait for it to go away
   0165 81             87                 RTS
                       88
                       89 *     Output subroutine
                       90
   0166 A6 08          91 OUTPUT          LDA       #008H           Get max bit count
   0168 B7 11          92                 STA       COUNT
   016A B6 10          93                 LDA       TREG            Retrieve command
   016C B7 01          94                 STA       PORTB           Put CMD in output port
   016E 16 00          95                 BSET      3,PORTA         Set CMD FLAG = 1
   0170 18 00          96 LOOP4           BSET      4,PORTA         Set CMD CLK = 1
   0172 AD 2D          97                 BSR       DELAY           Delay
   0174 19 00          98                 BCLR      4,PORTA         Set CMD CLK = 0
   0176 AD 29          99                 BSR       DELAY           Delay
   0178 38 01         100                 LSL       PORTB           Move next bit into d7
   017A 3A 11         101                 DEC       COUNT           Count shift
   017C 26 F2         102                 BNE       LOOP4           Not done - loop back
                      103
   017E 17 00         104                 BCLR      3,PORTA         Set CMD FLAG = 0
   0180 A6 C8         105                 LDA       #0C8H           Preset timer counter
   0182 B7 08         106                 STA       TDATA             to 200d.
   0184 0400 01       107 LOOP5           BRSET     2,PORTA,TIME    Test for ACK
   0187 81            108                 RTS                       Acknowlege received
                      109
   0188 B6 08         110 TIME            LDA       TDATA           Test time out
   018A 26 F8         111                 BNE       LOOP5           More time - LOOP5
                      112
   018C 1C 00         113 ERROR           BSET      6,PORTA         Set error bit = 1
   018E 0B00 FB       114                 BRCLR     5,PORTA,ERROR   Wait for 9816 to get
```

```
LOCATION OBJECT CODE LINE     SOURCE LINE

    0191 1D 00          115                 BCLR          6,PORTA         error flg & ACK.
    0193 9C             116                 RSP                          Reset SP to $7F
                        117
    0194 A6 05          118                 LDA           #05H           Loop delay 4 times
    0196 AE FF          119 LOOP8           LDX           #0FFH          Setup delay
    0198 CD 01A3        120                 JSR           DELAY2           for ~10 ms
    019B 4A             121                 DECA
    019C 26 F8          122                 BNE           LOOP8
    019E CC 0100        123                 JMP           INIT           Abnormal exit from
                        124 *                                              subroutine to CMD
                        125 *                                              wait loop.
                        126
                        127 *   Delay overhead 16 cycles; delay loop time 8 cycles.
                        128
    01A1 AE 08          129 DELAY           LDX           #008H          Start delay loop
    01A3 5A             130 DELAY2          DECX
    01A4 26 FD          131                 BNE           DELAY2         Loop till X=0
    01A6 81             132                 RTS
                        133
    01A7 AE 02          134 DEL             LDX           #002H
    01A9 BF 14          135                 STX           DCOUNT3
    01AB 5F             136                 CLRX
    01AC BF 13          137                 STX           DCOUNT2
    01AE BF 12          138                 STX           DCOUNT1
    01B0 3A 12          139 DEL1            DEC           DCOUNT1
    01B2 26 FC          140                 BNE           DEL1
    01B4 3A 13          141                 DEC           DCOUNT2
    01B6 26 F8          142                 BNE           DEL1
    01B8 3A 14          143                 DEC           DCOUNT3
    01BA 26 F4          144                 BNE           DEL1
    01BC 81             145                 RTS
                        146
                        147                 ORG           0F38H          Setup Mask Option
    0F38 37             148                 FCB           0037H             Register
                        149
                        150                 ORG           0FF8H          Initialize Vectors
    0FF8 01000100       151                 FDB           INIT,INIT,INIT,INIT
                        152
                        153                 END

Errors=     0
```

```
FILE: NRL_CMD·NRL885     CROSS REFERENCE TABLE          PAGE   4

LINE#   SYMBOL          TYPE     REFERENCES

   15  COUNT             A  92,101
   16  DCOUNT1           A  138,139
   17  DCOUNT2           A  137,141
   18  DCOUNT3           A  135,143
  134  DEL               A
  139  DEL1              A  140,142,144
  129  DELAY             A  56,97,99
  130  DELAY2            A  62,120,131
  113  ERROR             A  75,114
   24  INIT              A  123,151,151,151,151
   39  LOOP1             A  39
   83  LOOP10            A  85
   86  LOOP11            A  83,86
   75  LOOP2             A  77
   96  LOOP4             A  102
  107  LOOP5             A  111
   72  LOOP6             A  72
   61  LOOP7             A  64
  119  LOOP8             A  122
   80  LOOP9             A  68,80
   91  OUTPUT            A  67,69
   53  PCTL0             A  53
   45  PCTL1             A  45
    8  PORTA             A  29,32,36,39,42,45,50,53,57,66,72,75,80,83,86,95,96,98,104,107,113,114,115
    9  PORTB             A  30,94,100
   10  PORTC             A  31,48
   11  PORTD             A
   36  START             A  36,78
   13  TCONT             A  34
   12  TDATA             A  74,76,82,84,106,110
  110  TIME              A  107
   14  TREG              A  49,93
```

Section I-5

Section I-5
PLOTXY PROGRAM LISTING

```
10!           *************************
20!           *    PROGRAM PLOTXY     *
30!           *************************
40!
50!           Written by Kris Parrish
60!
70     DIM Sd(100,12),Read_string$[20],Clear$[2],Disp_flag$[8],Disp_msg$[60]
80     DIM File_string$[7],Disk_string$[14],Off_flag$[8],On_flag$[8],Title$[35]
90     DIM Plot_x(100),Plot_y(100),Test_data(100)
100    !
110    INTEGER I                       ! For loop counter
120    Data_count=0                    ! Used for writing star data to file
130    Max_dat=20                      ! Maximum # of data sets for a single
140                                    !  write to a data file.
150    Max_num_files=5                 ! Maximum number of data files allowed
160    Nfiles=0                        ! String designator for concatenation
170                                    !  of data file name, to be used for mult
180                                    !  data files
190    File_string$="FILE_"
200    Disk_string$=":HP82901,700,1"
210    Read_string$="FILE_0:HP89201,700,1"
220    Clear$=CHR$(255)&CHR$(75)
230    Inv_off=128                     ! Code for video attributes OFF
240    Inv_on=129                      ! Code for inverse video ON
250    !
260    Off_flag$="ON/"&CHR$(Inv_on)&"OFF"&CHR$(Inv_off)
270    On_flag$=CHR$(Inv_on)&"ON"&CHR$(Inv_off)&"/OFF"
280    !
290    Star1_flag=0                    ! Plot star #1 OFF
300    Star2_flag=0                    ! Plot star #2 OFF
310    Star3_flag=0                    ! Plot star #3 OFF
320    Data_read=0                     ! Show that a data file hasn't been read yet
330    Print_graph=0                   ! Send current graph to printer OFF
340    X_minimum=9999                  ! Initialize Min and Max values
350    X_maximum=-9999
360    Y_minimum=9999
370    Y_maximum=-9999
380    DEG                             ! Initialize graphics stuff...
390    GINIT
400    GRAPHICS ON
410    PRINTER IS 1
420 !
430 !      ****************************
440 !      *        Main_menu         *
450 !      ****************************
460 !
470 !      Define and display soft key functions
480 !
490 Main_menu:  !
500      ON KEY 0 LABEL "Re-display",3 GOTO Redisp_screen
510      ON KEY 1 LABEL "Star #1",3 GOSUB Star_1
520      ON KEY 2 LABEL "Star #2",3 GOSUB Star_2
530      ON KEY 3 LABEL "Star #3",3 GOSUB Star_3
540      ON KEY 4 LABEL "Data file #",3 GOSUB Data_file
550      ON KEY 5 LABEL "X vs Y",3 GOSUB X_vs_y
560      ON KEY 6 LABEL "X vs Time",3 GOSUB X_vs_time
570      ON KEY 7 LABEL "Y vs Time",3 GOSUB Y_vs_time
580      ON KEY 8 LABEL "Dump Graph",3 GOSUB Print_graphics
590      ON KEY 9 LABEL "EXIT",3 GOTO Shutdown
600      OUTPUT 2;Clear$;
```

```
610 !
620 !      ****************************
630 !      *       Menu_loop          *
640 !      ****************************
650 !
660 !      Display menu options on the screen
670 !
680 Menu_loop:  !
690    CONTROL 1:31,1
700    PRINT "PLOT PROGRAM MENU"
710    CONTROL 1:30,3
720    PRINT "k0  Redisplay Screen (Clear Graphics)"
730    CONTROL 1:30,4
740    PRINT "k1  Star #1 "
750    CONTROL 1:30,5
760    PRINT "k2  Star #2 "
770    CONTROL 1:30,6
780    PRINT "k3  Star #3 "
790    CONTROL 1:30,7
800    PRINT "k4  Data File # "
810    CONTROL 1:30,8
820    PRINT "k5  X vs Y "
830    CONTROL 1:30,9
840    PRINT "k6  X vs Time "
850    CONTROL 1:30,10
860    PRINT "k7  Y vs Time "
870    CONTROL 1:30,11
880    PRINT "k8  Dump Screen Graphics"
890    CONTROL 1:30,12
900    PRINT "     to Printer"
910    CONTROL 1:30,13
920    PRINT "k9  Exit Program"
930    GOSUB Check_flags
940    GOTO Menu_loop
950 !
960 !      ****************************
970 !      *       Check_flags        *
980 !      ****************************
990 !
1000!      Check the status of the flags displayed
1010!      on the screen.
1020!
1030 Check_flags: !
1040   CONTROL 1:42,4                      ! Star #1
1050   SELECT Star1_flag
1060      CASE 0
1070         Disp_flag$=Off_flag$
1080      CASE 1
1090         Disp_flag$=On_flag$
1100   END SELECT
1110   PRINT Disp_flag$
1120   CONTROL 1:42,5                      ! Star #2
1130      SELECT Star2_flag
1140         CASE 0
1150            Disp_flag$=Off_flag$
1160         CASE 1
1170            Disp_flag$=On_flag$
1180      END SELECT
1190      PRINT Disp_flag$
1200      CONTROL 1:42,6                   ! Star #3
```

```
1210  SELECT Star3_flag
1220     CASE 0
1230        Disp_flag$=Off_flag$
1240     CASE 1
1250        Disp_flag$=On_flag$
1260  END SELECT
1270  PRINT Disp_flag$
1280!
1290! DATA FILE # ( Enabled-File read, Disabled- File not read)
1300!
1310  CONTROL 1;46,7
1320  IF Data_read=1 THEN
1330     PRINT "[";Nfiles;"]                             "
1340  ELSE
1350     PRINT "   Disabled- file not read"
1360  END IF
1370  RETURN
1380!
1390!     ****************************
1400!     *       Data_file          *
1410!     ****************************
1420!
1430!     Get user input as to which data file
1440!     to use.
1450!
1460 Data_file: !
1470    BEEP
1480    INPUT "Please input file # > ",Nfiles
1490    IF Nfiles>=0 AND Nfiles<=99 THEN Input_ok
1500       BEEP
1510       Disp_msg$="Invalid file # "&VAL$(Nfiles)&" Please, try again !"
1520       GOSUB Out_msg
1530       GOTO Data_file
1540!
1550!     ****************************
1560!     *       Input_ok           *
1570!     ****************************
1580!
1590!      Open and read data file, filling
1600!      the array with the star values.
1610!
1620 Input_ok: !
1630   ON ERROR GOTO Error_tst                  ! Any file errors are taken
1640                                            !  care of in this routine...
1650   Number$=VAL$(Nfiles)                     ! Set up for concat. of filename
1660   File_string$[6]=Number$[1]               ! Create file name
1670   MASS STORAGE IS ":HP82901.700,1"         ! Designate rt drive for data
1680   ASSIGN @Path_1 TO File_string$
1690   DISP "Opening file > ";File_string$      ! Let user know what's going on
1700   Read_string$=File_string$&Disk_string$
1710   ASSIGN @F_1 TO Read_string$
1720   ENTER @F_1;Sd(*)                         ! Read in the data
1730   DISP "File read completed"               ! Let user know it is done
1740   Data_read=1                              ! Show Data has been read...
1750   ASSIGN @F_1 TO *                         ! Close the data file
1760   WAIT 1                                   ! Delay so user can read message
1770   DISP                                     ! Clear display line
1780   OFF ERROR                                ! Turn off error trapping
1790   RETURN                                   ! Done!
1800!
```

```
1810!     ***************************
1820!     *        Error_tst        *
1830!     ***************************
1840!
1850!     This is used for testing of data file
1860!     errors.
1870!
1880 Error_tst: !
1890    OFF ERROR
1900    BEEP
1910    IF ERRN=56 THEN
1920       DISP "File # ";Nfiles;" does not exist, press <CONT> to continue"
1930       PAUSE
1940    ELSE
1950       IF ERRN=80 THEN
1960          DISP "Disc not changed or NOT located in the right hand drive..."
1970          WAIT .5
1980          DISP "Press <CONT> after placing correct disc in right drive"
1990          PAUSE
2000       ELSE
2010       CONTROL 1;1,24
2020       PRINT "Unexpected error (";ERRN;") consult list of errors"
2030       PRINT "and correct problem... press <CONT> to try again!"
2040       PAUSE
2050    END IF
2060    END IF
2070    GOTO Data_file
2080!
2090!     ***************************
2100!     *       X_vs_y            *
2110!     ***************************
2120!
2130!     Plot X position vs Y position
2140!
2150 X_vs_y:!
2160    IF Data_read=0 THEN                  ! A data file hasn't been read in yet
2170       Disp_msg$="You must first read in a data file before you can plot..."
2180       GOSUB Out_msg
2190       RETURN
2200    END IF
2210    OUTPUT 2;Clear$;
2220    FRAME
2230    WINDOW -5,270,-5,270
2240    AXES 2,2,-5,-5,5,5,5
2250    Npts=0
2260    FOR I=1 TO 100
2270       IF Sd(I,10)=0 AND Sd(I,11)=0 AND Sd(I,12)=0 THEN 2300
2280          Npts=Npts+1
2290    NEXT I
2300    IF Npts=0 THEN
2310       Npts=1
2320    END IF
2330  !
2340  !   LABEL THE X AXIS
2350  !
2360    X_maximum=260
2370    Step_size=20
2380    X_offset=10
2390    GOSUB Label_x
2400  !
```

```
2410  !   LABEL THE Y AXIS
2420  !
2430     Y_maximum=260
2440     Step_size=20
2450     Y_offset=12
2460     GOSUB Label_y
2470  !
2480  ! LABEL THE PLOT
2490  !
2500     Title$="X vs Y from "&File_string$
2510     Location_x=137
2520     Location_y=255
2530     GOSUB Label_plot
2540  !
2550     IF Star1_flag=0 THEN Plot_star_2
2560        FOR I=1 TO Npts
2570           Plot_x(I)=Sd(I,1)
2580           Plot_y(I)=Sd(I,2)
2590        NEXT I
2600        Line_type=1
2610        Line_label$="STAR #1"
2620        GOSUB Plot_star
2630!
2640!       ****************************
2650!       *        Plot_star_2       *
2660!       ****************************
2670!
2680 Plot_star_2:!
2690     IF Star2_flag=0 THEN Plot_star_3
2700        FOR I=1 TO Npts
2710           Plot_x(I)=Sd(I,4)
2720           Plot_y(I)=Sd(I,5)
2730        NEXT I
2740        Line_type=5
2750        Line_label$="STAR #2"
2760        GOSUB Plot_star
2770!
2780!       ****************************
2790!       *        Plot_star_3       *
2800!       ****************************
2810!
2820 Plot_star_3:!
2830     IF Star3_flag=0 THEN RETURN
2840        FOR I=1 TO Npts
2850           Plot_x(I)=Sd(I,7)
2860           Plot_y(I)=Sd(I,8)
2870        NEXT I
2880        Line_type=3
2890        Line_label$="STAR #3"
2900        GOSUB Plot_star
2910        RETURN
2920!
2930!       ****************************
2940!       *        Star_1            *
2950!       ****************************
2960!
2970!       Toggle star #1 flag
2980!
2990 Star_1:!
3000     Star1_flag=1-Star1_flag
```

```
3010    RETURN
3020!
3030!     ***************************
3040!     *        Star_2           *
3050!     ***************************
3060!
3070!     Toggle star #2 flag
3080!
3090 Star_2:!
3100    Star2_flag=1-Star2_flag
3110    RETURN
3120!
3130!     ***************************
3140!     *        Star_3           *
3150!     ***************************
3160!
3170!     Toggle star #3 flag
3180!
3190 Star_3:!
3200    Star3_flag=1-Star3_flag
3210    RETURN
3220!
3230!     ***************************
3240!     *        X_vs_time        *
3250!     ***************************
3260!
3270!     Plot X position vs time
3280!
3290 X_vs_time:!
3300    IF Data_read=0 THEN
3310      Disp_msg$="You must first read in a data file before you can plot..."
3320      GOSUB Out_msg
3330      RETURN
3340    END IF
3350    OUTPUT 2;Clear$;
3360    FRAME
3370    CONTROL 1;20,18
3380    PRINT CHR$(Inv_on)&"Determining MINIMUM and MAXIMUM values"&CHR$(Inv_off

3390    X_maximum=-9999                      ! Initialize Maximum value
3400    X_minimum=9999                       ! Initialize Minimum value
3410    Npts=0
3420    FOR I=1 TO 100
3430      IF Sd(I,10)=0 AND Sd(I,11)=0 AND Sd(I,12)=0 THEN 3490
3440        Npts=Npts+1
3450        Test_data(I)=Sd(I,12)+(60*Sd(I,11))
3460        IF X_maximum<Test_data(I) THEN X_maximum=Test_data(I)
3470        IF X_minimum>Test_data(I) THEN X_minimum=Test_data(I)
3480    NEXT I
3490    IF Npts=0 THEN
3500      Npts=1
3510      X_maximum=60
3520      X_minimum=0
3530    END IF
3540    X_maximum=X_maximum+20
3550    WINDOW X_minimum,X_maximum,-5,270
3560    AXES 1,2,X_minimum,-5,5,5,5
3570  !
3580  ! Label the X axis
3590  !
```

```
3600    Step_size=10
3610    X_offset=15
3620    GOSUB Label_x
3630 !
3640 ! Label the Y axis
3650 !
3660    Y_maximum=260
3670    Step_size=20
3680    Y_offset=X_minimum+15
3690    GOSUB Label_y
3700 !
3710 ! Label the plot
3720 !
3730    Title$="X vs TIME from "&File_string$
3740    Location_x=X_minimum+125
3750    Location_y=255
3760    GOSUB Label_plot
3770 !
3780 ! START PLOTTING...
3790 !
3800    CONTROL 1:20,18
3810    PRINT "                                                 "
3820    IF Star1_flag=0 THEN Plot_x_star2
3830       FOR I=1 TO Npts
3840          Plot_x(I)=Test_data(I)
3850          Plot_y(I)=Sd(I,1)
3860       NEXT I
3870       Line_type=1
3880       Line_label$="STAR #1"
3890       GOSUB Plot_star
3900!
3910!     *****************************
3920!     *       Plot_x_star2        *
3930!     *****************************
3940!
3950 Plot_x_star2:!
3960    IF Star2_flag=0 THEN Plot_x_star3
3970       FOR I=1 TO Npts
3980          Plot_x(I)=Test_data(I)
3990          Plot_y(I)=Sd(I,4)
4000       NEXT I
4010       Line_type=5
4020       Line_label$="STAR #2"
4030       GOSUB Plot_star
4040!
4050!     *****************************
4060!     *       Plot_x_star3        *
4070!     *****************************
4080!
4090 Plot_x_star3:!
4100    IF Star3_flag=0 THEN RETURN
4110       FOR I=1 TO Npts
4120          Plot_x(I)=Test_data(I)
4130          Plot_y(I)=Sd(I,7)
4140       NEXT I
4150       Line_type=3
4160       Line_label$="STAR #3"
4170       GOSUB Plot_star
4180       RETURN
4190!
```

```
4200!      ***************************
4210!      *        Y_vs_time        *
4220!      ***************************
4230!
4240!      Plot Y position vs time
4250!
4260 Y_vs_time:!
4270    IF Data_read=0 THEN
4280       Disp_msg$="You must first read in a data file before you can plot..."
4290       GOSUB Out_msg
4300    END IF
4310    OUTPUT 2;Clear$;
4320    FRAME
4330    CONTROL 1;20,18
4340    PRINT CHR$(Inv_on)&"Determining MINIMUM and MAXIMUM values"&CHR$(Inv_off
)
4350    X_maximum=-9999
4360    X_minimum=9999
4370    Npts=0
4380    FOR I=1 TO 100
4390       IF Sd(I,10)=0 AND Sd(I,11)=0 AND Sd(I,12)=0 THEN 4450
4400          Npts=Npts+1
4410          Test_data(I)=Sd(I,12)+(60*Sd(I,11))
4420          IF X_maximum<Test_data(I) THEN X_maximum=Test_data(I)
4430          IF X_minimum>Test_data(I) THEN X_minimum=Test_data(I)
4440    NEXT I
4450    IF Npts=0 THEN
4460       Npts=1
4470       X_maximum=60
4480       X_minimum=0
4490    END IF
4500    X_maximum=X_maximum+20
4510    WINDOW X_minimum,X_maximum,-5,270
4520    AXES 2,2,X_minimum,-5,5,5,5
4530 !
4540 ! Label the X axis
4550 !
4560    Step_size=10
4570    X_offset=15
4580    GOSUB Label_x
4590 !
4600 ! Label the Y axis
4610 !
4620    Y_maximum=260
4630    Step_size=20
4640    Y_offset=X_minimum+15
4650    GOSUB Label_y
4660 !
4670 ! Label the plot
4680 !
4690    Title$="Y vs TIME from "&File_string$
4700    Location_x=X_minimum+125
4710    Location_y=255
4720    GOSUB Label_plot
4730 !
4740 ! START PLOTTING Y vs TIME...
4750 !
4760    CONTROL 1;20,18
4770    PRINT "
4780    IF Star1_flag=0 THEN Plot_y_star2
```

```
4790       FOR I=1 TO Npts
4800          Plot_x(I)=Test_data(I)
4810          Plot_y(I)=Sd(I,2)
4820       NEXT I
4830       Line_type=1
4840       Line_label$="STAR #1"
4850       GOSUB Plot_star
4860!
4870!     ****************************
4880!     *       Plot_y_star2       *
4890!     ****************************
4900!
4910 Plot_y_star2:!
4920    IF Star2_flag=0 THEN Plot_y_star3
4930       FOR I=1 TO Npts
4940         Plot_x(I)=Test_data(I)
4950         Plot_y(I)=Sd(I,5)
4960      NEXT I
4970      Line_type=5
4980      Line_label$="STAR #2"
4990      GOSUB Plot_star
5000!
5010!     ****************************
5020!     *       Plot_y_star3       *
5030!     ****************************
5040!
5050 Plot_y_star3:!
5060    IF Star3_flag=0 THEN RETURN
5070       FOR I=1 TO Npts
5080          Plot_x(I)=Test_data(I)
5090          Plot_y(I)=Sd(I,8)
5100       NEXT I
5110       Line_type=3
5120       Line_label$="STAR #3"
5130       GOSUB Plot_star
5140       RETURN
5150!
5160!     ****************************
5170!     *      Print_graphics      *
5180!     ****************************
5190!
5200 Print_graphics:!
5210    DUMP GRAPHICS
5220    PRINTER IS 701
5230    PRINT
5240    PRINT
5250    PRINTER IS 1
5260    GCLEAR
5270    RETURN
5290!
5290!     ****************************
5300!     *         Label_x          *
5310!     ****************************
5320!
5330 Label_x:!
5340    LORG 6
5350    CSIZE 3,.7
5360    LDIR 90
5370    FOR I=0 TO X_maximum STEP Step_size
5380       MOVE I,X_offset
```

```
5390       LABEL I
5400    NEXT I
5410    RETURN
5420!
5430!     ****************************
5440!     *       Label_y            *
5450!     ****************************
5460!
5470 Label_y:!
5480    LDIR 0
5490    CSIZE 2.6,.6
5500    LORG 8
5510    FOR I=0 TO Y_maximum STEP Step_size
5520       MOVE Y_offset,I
5530       LABEL I
5540    NEXT I
5550    RETURN
5560!
5570!     ****************************
5580!     *       Label_plot         *
5590!     ****************************
5600!
5610 Label_plot:!
5620    CSIZE 7,.6
5630    LORG 5
5640    LDIR 0
5650    MOVE Location_x,Location_y
5660    LABEL Title$
5670    RETURN
5680!
5690!     ****************************
5700!     *       Plot_star          *
5710!     ****************************
5720!
5730 Plot_star:!
5740    CSIZE 2.5,1.5
5750    LINE TYPE Line_type
5760    MOVE Plot_x(1),Plot_y(1)
5770    FOR I=1 TO Npts
5780       DRAW Plot_x(I),Plot_y(I)
5790    NEXT I
5800    LINE TYPE 1
5810    IF Plot_y(100)=0 THEN Plot_y(100)=25
5820    IF Plot_x(100)=0 THEN Plot_x(100)=35
5830    MOVE Plot_x(100)-5,Plot_y(100)+5
5840    LABEL Line_label$
5850    MOVE 0,0
5860    RETURN
5870!
5880!     ****************************
5890!     *       Redisp_screen      *
5900!     ****************************
5910!
5920 Redisp_screen:!
5930    OUTPUT 2;Clear$;
5940    GCLEAR
5950    GOTO Menu_loop
5960!
5970!     ****************************
5980!     *       Out_msg            *
```

```
5990!     ****************************
6000!
6010 Out_msg:!
6020    BEEP
6030    DISP Disp_msg$
6040    WAIT 2
6050    DISP
6060    RETURN
6070!
6080!     ****************************
6090!     *       Shutdown           *
6100!     ****************************
6110!
6120 Shutdown:!
6130    OFF KEY
6140    OUTPUT 2;Clear$;
6150    GCLEAR
6160    PRINT "PLOT PROGRAM TERMINATED..."
6170    END
```

Section I-6

Section I-6
ERROR MESSAGES

Error Messages

1 Missing ROM or configuration error. Loading a program or binary file that is not compatible with the language system. For example, trying to load the 1.0 PHYREC Binary into a 2.0 system, or loading a program containing 2.0 keywords into a 1.0 system.

2 Memory overflow. If you get this error while loading a file, the program is too large for the computer's memory. If the program loads, but you get this error when you press RUN, then the overflow was caused by the variable declarations. Either way, you need to modify the program or add more read/write memory.

3 Line not found in current context. Could be a GOTO or GOSUB that references a non-existent (or deleted) line, or an EDIT command that refers to a non-existent line label.

4 Improper RETURN. Executing a RETURN statement without previously executing an appropriate GOSUB or function call. Also, a RETURN statement in a user-defined function with no value specified.

5 Improper context terminator. You forgot to put an END statement in the program. Also applies to SUBEND and FNEND.

6 Improper FOR...NEXT matching. Executing a NEXT statement without previously executing the matching FOR statement. Indicates improper nesting or overlapping of the loops.

7 Undefined function or subprogram. Attempt to call a SUB or user-defined function that is not in memory. Look out for program lines that assumed an optional CALL.

8 Improper parameter matching. A type mismatch between a pass parameter and a formal parameter of a subprogram.

9 Improper number of parameters. Passing either too few or too many parameters to a subprogram. Applies only to non-optional parameters.

10 String type required. Attempting to return a numeric from a user-defined string function.

11 Numeric type required. Attempting to return a string from a user-defined numeric function.

12 Attempt to redeclare variable. Including the same variable name twice in declarative statements such as DIM or INTEGER.

13 Array dimensions not specified. Using the (*) symbol after a variable name when that variable has never been declared as an array.

14 OPTION BASE not allowed here. The OPTION BASE statement must appear before any declarative statements such as DIM or INTEGER. Only one OPTION BASE statement is allowed in one context.

15 Invalid bounds. Attempt to declare an array with more than 32 767 elements or with upper bound less than lower bound.

16 Improper or inconsistent dimensions. Using the wrong number of subscripts when referencing an array element.

17 Subscript out of range. A subscript in an array reference is outside the current bounds of the array.

18 String overflow or substring error. String overflow is an attempt to put too many characters into a string (exceeding dimensioned length). This can happen in an assignment. an ENTER an INPUT, or a READ. A substring error is an attempted violation of the rules for substrings (see Chapter 5). Watch out for null strings where you weren't expecting them.

19 Improper value or out of range. A value is too large or too small. Applies to items found in a variety of statements. Often occurs when the number builder overflows (or underflows) during an I/O operation.

20 INTEGER overflow. An assignment or result exceeds the range allowed for INTEGER variables. Must be −32 768 thru 32 767.

22 REAL overflow. An assignment or result exceeds the range allowed for REAL variables. (See Chapter 4.)

24 Trig argument too large for accurate evaluation. Out-of-range argument for a function such as TAN or LDIR.

25 Magnitude of ASN or ACS argument is greater than 1. Arguments to these functions must be in the range −1 thru +1.

26 Zero to non-positive power. Exponentiation error.

27 Negative base to non-integer power. Exponentiation error.

28 LOG or LGT of a non-positive number.

29 Illegal floating point number. Does not occur as a result of any calculations. but is possible when a FORMAT OFF I/O operation fills a REAL variable with something other than a REAL number.

30 SQR of a negative number.

31 Division (or MOD) by zero.

32 String does not represent a valid number. Attempt to use "non-numeric" characters as an argument for VAL, data for a READ. or in response to an INPUT statement requesting a number

33 Improper argument for NUM or RPT$. Null string not allowed.

34 Referenced line not an IMAGE statement. A USING clause contains a line identifier and the line referred to is not an IMAGE statement.

35 Improper image. See IMAGE or the appropriate keyword in the *BASIC Language Reference*.

36 Out of data in READ. A READ statement is expecting more data than is available in the referenced DATA statements. Check for deleted lines, proper OPTION BASE, proper use of RESTORE, or typing errors.

38 TAB or TABXY not allowed here. The tab functions are not allowed in statements that contain a USING clause. TABXY is allowed only in a PRINT statement.

40 Improper REN, COPYLINES, or MOVELINES command. Line numbers must be whole numbers from 1 to 32 766. This may also result from a COPYLINES or MOVELINES statement whose destination line numbers lie within the source range.

41 First line number greater than second line number. Parameters out of order in a statement like SAVE, LIST, or DEL.

43 Matrix must be square. The MAT functions: IDN, INV, and DET require the array to have equal numbers of rows and columns.

44 Result cannot be an operand. Attempt to use a matrix as both result and argument in a MAT TRN or matrix multiplication.

46 Attempting a SAVE when there is no program in memory or a STORE BIN when there are no binary programs in memory.

47 COM declarations are inconsistent or incorrect. Includes such things as mismatched dimensions, unspecified dimensions, and blank COM occurring for the first time in a subprogram.

49 Branch destination not found. A statement such as ON ERROR or ON KEY refers to a line that does not exist. Branch destinations must be in the same context as the ON...statement.

51 File not currently assigned. Attempting an ON/OFF END statement with an unassigned I/O path name.

52 Improper mass storage unit specifier. The characters used for a msus do not form a valid specifier. This could be a missing colon, too many parameters, illegal characters, etc.

53 Improper file name. File names are limited to 10 characters. Foreign characters are allowed. but punctuation is not.

54 Duplicate file name. The specified file name already exists in directory. It is illegal to have two files with the same name on one volume.

55 Directory overflow. Although there may be room on the media for the file, there is no room in the directory for another file name. Discs initialized by BASIC have room for over 100 entries in the directory, but other systems may make a directory of a different size.

56 File name is undefined The specified file name does not exist in the directory Check the contents of the disc with a CAT command.

58 Improper file type. Many mass storage operations are limited to certain file types. For example, LOAD is limited to PROG files and ASSIGN is limited to ASCII and BDAT files.

59 End of file or buffer found. For files: No data left when reading a file, or no space left when writing a file. For buffers: No data left for an ENTER, or no buffer space left for an OUTPUT Also, WORD-mode TRANSFER terminated with odd number of bytes.

60 End of record found in random mode. Attempt to ENTER a field that is larger than a defined record.

62 Protect code violation. Failure to specify the protect code of a protected file, or attempting to protect a file of the wrong type.

64 Mass storage media overflow There is not enough contiguous free space for the specified file size. The disc is full.

66 INITIALIZE failed. Too many bad tracks found. The disc is defective, damaged, or dirty.

67 Illegal mass storage parameter. A mass storage statement contains a parameter that is out of range, such as a negative record number or an out of range number of records.

68 Syntax error occurred during GET. One or more lines in the file could not be stored as valid program lines. The offending lines are usually listed on the system printer. Also occurs if the first line in the file does not start with a valid line number.

72 Disc controller not found or bad controller address. The msus contains an improper device selector, or no external disc is connected.

73 Improper device type in mass storage unit specifier. The msus has the correct general form, but the characters used for a device type are not recognized.

76 Incorrect unit number in mass storage unit specifier. The msus contains a unit number that does not exist on the specified device.

77 Attempt to purge an open file. The specified file is assigned to an I/O path name which has not been closed.

78 Invalid mass storage volume label. Usually indicates that the media has not been initialized on a compatible system. Could also be a bad disc.

79 File open on target device. Attempt to copy an entire volume with a file open on the destination disc.

80 Disc changed or not in drive. Either there is no disc in the drive or the drive door was opened while a file was assigned.

81 Mass storage hardware failure. Also occurs when the disc is pinched and not turning. Try reinserting the disc.

82 Mass storage unit not present. Hardware problem or an attempt to access a left-hand drive on the Model 26.

83 Write protected. Attempting to write to a write_protected disc. This includes many operations such as PURGE, INITIALIZE, CREATE, SAVE, OUTPUT, etc.

84 Record not found. Usually indicates that the media has not been initialized.

85 Media not initialized. (Usually not produced by the internal drive.)

87 Record address error. Usually indicates a problem with the media.

88 Read data error. The media is physically or magnetically damaged, and the data cannot be read.

89 Checkread error. An error was detected when reading the data just written. The media is probably damaged.

90 Mass storage system error. Usually a problem with the hardware or the media.

100 Numeric IMAGE for string item.

101 String IMAGE for numeric item.

102 Numeric field specifier is too large. Specifying more than 160 characters in a numeric field

103 Item has no corresponding IMAGE. The image specifier has no fields that are used for item processing. Specifiers such as * X / are not used to process the data for the item list. Item-processing specifiers include things like K D B A.

105 Numeric IMAGE field too small. Not enough characters are specified to represent the number

106 IMAGE exponent field too small. Not enough exponent characters are specified to represent the number.

107 IMAGE sign specifier missing. Not enough characters are specified to represent the number Number would fit except for the minus sign.

117 Too many nested structures. The nesting level is too deep for such structures as FOR. SELECT. IF. LOOP. etc.

118 Too many structures in context. Refers to such structures as FOR/NEXT. IF/THEN/ELSE. SELECT/CASE. WHILE. etc.

120 Not allowed while program running. The program must be stopped before you can execute this command.

121 Line not in main program. The run line specified in a LOAD or GET is not in the main context

122 Program is not continuable. The program is in the stopped state. not the paused state. CONT is allowed only in the paused state.

126 Quote mark in unquoted string. Quote marks must be used in pairs.

127 Statements which affect the knob mode are out of order.

128 Line too long during GET.

131 Unrecognized non-ASCII keycode. An output to the keyboard contained a CHR$(255) followed by an illegal byte.

132 Keycode buffer overflow. Trying to send too many characters to the keyboard buffer with an OUTPUT 2 statement.

133 DELSUB of non-existent or busy subprogram.

134 Improper SCRATCH statement

135 READIO/WRITEIO to nonexistent memory location.

136 REAL underflow The input or result is closer to zero than 10^{-308} (approximately).

140 Too many symbols in the program. Symbols are variable names. I/O path names. COM block names. subprogram names. and line identifiers.

141 Variable cannot be allocated. It is already allocated.

142 Variable not allocated. Attempt to DEALLOCATE a variable that was not allocated

143 Reference to missing OPTIONAL parameter The subprogram is trying to use an optional parameter that didn't have any value passed to it. Use NPAR to check the number of passed parameters.

145 May not build COM at this time Attempt to add or change COM when a program is running For example. a program does a LOADSUB and the COM in the new subprogram does not match existing COM.

146 Duplicate line label in context. There cannot be two lines with the same line label in one context.

150 Illegal interface select code or device selector. Value out of range.

152 Parity error

153 Insufficient data for ENTER. A statement terminator was received before the variable list was satisfied.

154 String greater than 32 767 bytes in ENTER.

155 Improper interface register number. Value out of range or negative.

156 Illegal expression type in list. For example, trying to ENTER into a constant.

157 No ENTER terminator found. The variable list has been satisfied, but no statement terminator was received in the next 256 characters. The # specifier allows the statement to terminate when the last item is satisfied.

158 Improper image specifier or nesting images more than 8 deep. The characters used for an image specifier are improper or in an improper order

159 Numeric data not received. When entering characters for a numeric field, an item terminator was encountered before any "numeric" characters were received.

160 Attempt to enter more than 32 767 digits into one number.

163 Interface not present. The intended interface is not present, set to a different select code, or is malfunctioning.

164 Illegal BYTE/WORD operation. Attempt to ASSIGN with the WORD attribute to a non-word device.

165 Image specifier greater than dimensioned string length.

167 Interface status error. Exact meaning depends upon the interface type. With HP-IB, this can happen when a non-controller operation by the computer is aborted by the bus.

168 Device timeout occurred and the ON TIMEOUT branch could not be taken.

170 I/O operation not allowed. The I/O statement has the proper form, but its operation is not defined for the specified device. For example, using an HP-IB statement on a non-HP-IB interface or directing a LIST to the keyboard.

171 Illegal I/O addressing sequence. The secondary addressing in a device selector is improper or primary address too large for specified device.

172 Peripheral error. PSTS line is false. If used, this means that the peripheral device is down. If PSTS is not being used, this error can be suppressed by using control register 2 of the GPIO

173 Active or system controller required. The HP-IB is not active controller and needs to be for the specified operation.

174 Nested I/O prohibited. An I/O statement contains a user-defined function. Both the original statement and the function are trying to access the same file or device

177 Undefined I/O path name. Attempting to use an I/O path name that is not assigned to a device or file.

178 Trailing punctuation in ENTER. The trailing comma or semicolon that is sometimes used at the end of OUTPUT statements is not allowed at the end of ENTER statements

301 Cannot do while connected.

303 Not allowed when trace active.

304 Too many characters without terminator.

306 Interface card failure. The datacomm card has failed self-test.

310 Not connected.

313 USART receive buffer overflow. Overrun error detected. Interface card is unable to keep up with incoming data rate. Data has been lost.

314 Receive buffer overflow. Program is not accepting data fast enough to keep up with incoming data rate. Data has been lost.

315 Missing data transmit clock. A transmit timeout has occurred because a missing data clock prevented the card from transmitting. The card has disconnected from the line.

316 CTS false too long. The interface card was unable to transmit for a predetermined period of time because Clear-To-Send was false on a half-duplex line. The card has disconnected from the line.

317 Lost carrier disconnect. Data Set Ready (DSR) or Data Carrier Detect (if full duplex) went inactive for too long.

318 No activity disconnect. The card has disconnected from the line because no data was transmitted or received for a predetermined length of time.

319 Connection not established. Data Set Ready or Data Carrier Detect (if full duplex) did not become active within a predetermined length of time.

324 Card trace buffer overflow.

325 Illegal databits parity combination. Attempting to program 8 bits-per-character and a parity of "1" or "0".

326 Register address out of range. A control or status register access was attempted to a non-existent register.

327 Register value out of range. Attempting to place an illegal value in a control register

328 USART Transmit underrun.

330 User-defined LEXICAL ORDER IS table size exceeds array size.

331 Repeated value in pointer. A MAT REORDER vector has repeated subscripts. This error is not always caught.

332 Non-existent dimension given. Attempt to specify a non-existent dimension in a MAT REORDER operation.

333 Improper subscript in pointer. A MAT REORDER vector specifies a non-existent subscript

334 Pointer size is not equal to the number of records. A MAT REORDER vector has a different number of elements than the specified dimension of the array.

335 Pointer is not a vector. Only single-dimension arrays (vectors) can be used as the pointer in a MAT REORDER or a MAT SORT statement.

337 Substring key is out-of-range. The specified substring range of the sort key exceeds the dimensioned length of the elements in the array

338 Key subscript out-of-range. Attempt to specify a subscript in a sort key outside the current bounds of the array.

340 Mode table too long. User-defined LEXICAL ORDER IS mode table contains more than 63 entries.

341 Improper mode indicator. User-defined LEXICAL ORDER IS table contains an illegal combination of mode type and mode pointer.

342 Not a single-dimension integer array. User-defined LEXICAL ORDER IS mode table must be a single-dimension array of type INTEGER.

343 Mode pointer is out of range. User-defined LEXICAL ORDER IS table has a mode pointer greater than the existing mode table size.

344 1 for 2 list empty or too long. A user-defined LEXICAL ORDER IS table contains an entry indicating an improper number of 1 for 2 secondaries.

345 CASE expression type mismatch. The SELECT statement and its CASE statements must refer to the same general type, numeric or string.

346 INDENT parameter out-of-range. The parameters must be in the range: 0 thru eight characters less than the screen width.

347 Structures improperly matched. There is not a corresponding number of structure beginnings and endings. Usually means that you forgot a statement such as END IF, NEXT, END SELECT, etc.

349 CSUB has been modified. A contiguous block of compiled subroutines has been modified since it was loaded. A single module that shows as multiple CSUB statements has been altered because program lines were inserted or deleted.

353 Data link failure.

401 Bad system function argument. An invalid argument was given to a time, date, base conversion, or SYSTEM$ function.

403 Copy failed; program modification incomplete. An error occurred during a COPYLINES or MOVELINES resulting in an incomplete operation. Some lines may not have been copied or moved.

427 Priority may not be lowered.

471 TRANSFER not supported by the interface.

488 DMA hardware required. HP 9885 disc drive requires a DMA card or is malfunctioning.

511 The result array in a MAT INV must be of type REAL.

600 Attribute cannot be modified. The WORD/BYTE mode cannot be changed after assigning the I/O path name.

601 Improper CONVERT lifetime When the CONVERT attribute is included in the assignment of an I/O path name, the name of a string variable containing the conversion is also specified. The conversion string must exist as long as the I/O path name is valid.

602 Improper BUFFER lifetime. The variable designated as a buffer during an I/O path name assignment must exist as long as the I/O path name is valid.

603 Variable was not declared as a BUFFER. Attempt to assign a variable as a buffer without first declaring the variable as a BUFFER.

604 Bad source or destination for a TRANSFER statement. Transfers are not allowed to the CRT. keyboard, or tape backup on CS80 drives. Buffer to buffer or device to device transfers are not allowed.

605 BDAT file type required. Only BDAT files can be used in a TRANSFER operation.

606 Improper TRANSFER parameters. Conflicting or invalid TRANSFER parameters were specified. such as RECORDS without and EOR clause. or DELIM with an outbound TRANSFER.

607 Inconsistent attributes. Such as CONVERT or PARITY with FORMAT OFF.

609 IVAL or DVAL result too large. Attempt to convert a binary, octal. decimal, or hexadecimal string into a value outside the range of the function.

612 BUFFER pointers in use. Attempt to change one or more buffer pointers while a TRANSFER is in progress.

700 Improper plotter specifier. The characters used as a plotter specifier are not recognized. May be misspelled or contain illegal characters.

702 CRT graphics hardware missing. Hardware problem.

704 Upper bound not greater than lower bound. Applies to P2<=P1 or VIEWPORT upper bound and CLIP limits.

705 VIEWPORT or CLIP beyond hard clip limits.

708 Device not initialized.

900 Undefined typing aid key.

901 Typing aid memory overflow.

902 Must delete entire context. Attempt to delete a SUB or DEF FN statement without deleting its entire context. Easiest way to delete is with DELSUB.

903 No room to renumber. While EDIT mode was renumbering during an insert, all available line numbers were used between insert location and end of program.

904 Null FIND or CHANGE string.

905 CHANGE would produce a line too long for the system. Maximum line length is 100 characters for the Model 26 and 160 characters for the Models 16 and 36.

906 SUB or DEF FN not allowed here. Attempt to insert a SUB or DEF FN statement into the middle of a context. Subprograms must be appended at the end.

909 May not replace SUB or DEF FN. Similar to deleting a SUB or DEF FN.

910 Identifier not found in this context. The keyboard-specified variable does not already exist in the program. Variables cannot be created from the keyboard; they must be created by running a program.

911 Improper I/O list.

920 Numeric constant not allowed.

921 Numeric identifier not allowed.

922 Numeric array element not allowed.

923 Numeric expression not allowed.

924 Quoted string not allowed.

925 String identifier not allowed.

926 String array element not allowed.

927 Substring not allowed.

928 String expression not allowed.

929 I/O path name not allowed.

930 Numeric array not allowed.

931 String array not allowed.

932 Excess keys specified. A sort key was specified following a key which specified the entire record.

935 Identifier is too long: 15 characters maximum.

936 Unrecognized character. Attempt to store a program line containing an improper name or illegal character.

937 Invalid OPTION BASE. Only 0 and 1 are allowed.

939 OPTIONAL appears twice. A parameter list may have only one OPTIONAL keyword. All parameters listed before it are required. all listed after it are optional.

940 Duplicate formal parameter name.

942 Invalid I/O path name. The characters after the @ are not a valid name. Names must start with a letter.

943 Invalid function name. The characters after the FN are not a valid name. Names must start with a letter.

946 Dimensions are inconsistent with previous declaration. The references to an array contain a different number of subscripts at different places in the program.

947 Invalid array bounds. Value out of range. or more than 32 767 elements specified.

948 Multiple assignment prohibited. You cannot assign the same value to multiple variables by stating X=Y=Z=0. A separate assignment must be made for each variable.

949 This symbol not allowed here. This is the general "syntax error" message. The statement you typed contains elements that don't belong together. are in the wrong order. or are misspelled.

950 Must be a positive integer.

951 Incomplete statement. This keyword must be followed by other items to make a valid statement.

961 CASE expression type mismatch. The CASE line contains items that are not the same general type. numeric or string.

962 Programmable only: cannot be executed from the keyboard.

963 Command only: cannot be stored as a program line.

977 Statement is too complex. Contains too many operators and functions. Break the expression down so that it is performed by two or more program lines.

980 Too many symbols in this context. Symbols include variable names. I/O path names. COM block names. subprogram names. and line identifiers.

982 Too many subscripts: maximum of six dimensions allowed.

983 Wrong type or number of parameters. An improper parameter list for a machine-resident function.

985 Invalid quoted string.

987 Invalid line number: must be a whole number 1 thru 32 766.